LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROJECT

COST BENEFIT ANALYSIS OF WETLANDS RESOURCES UGANDA

FINAL REPORT

PART II: ECONOMIC ANALYSIS

(DRAFT)

February 2001

HASKONING
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1 INTRODUCTION

1.1 Scope and content

The present study, Cost Benefit Analysis of Wetlands Resources, forms part of the Lake Victoria Environmental Management Project. Its aim is to define and quantify the values of wetlands and make this information available for awareness raising, policy making and wetland management.

The study considers a number of wetlands around Lake Victoria that form part of the Republic of Uganda. It concentrates on five Pilot Areas that are indicated in Figure 1.2.1, notably Sango Bay, Ssese Islands, Murchison Bay, Napoleon Gulf and Berkeley/ MacDonald Bays.

The study addresses first the present and future value of wetland resources and in a second stage develops scenarios to guarantee their sustainability. Finally, the study evaluates the economic appropriateness of those proposed scenarios through a cost-benefit analysis.

As a consequence the present report makes in Chapter 2 an appreciation of wetlands and their functions. Then, in Chapter 3 the approach for making an appraisal of wetland functions is described.

In Chapter 4 the report pays attention to the social-economic fabric of the wetlands in the Pilot Areas around Lake Victoria, addressing in particular the stakeholders, land use and the potential for fish spawning. In Chapter 5 details of the various economic wetland products and seNices are given and their value is estimated, while in Chapter 6 the same is done for the non-use functions that wetlands possess.

Chapter 7 deals with the actual Cost Benefit Analysis (CBA) of the development scenarios selected to guarantee the sustainability of a number of wetlands. It covers details of the scenarios and their costs, the likely benefits accruing from the proposed inteNentions and an economic appraisal in order to assess whether making the costs is worthwhile in social terms.

1.2 Data sources

The success of a study trying to make, on the one hand, an economic valuation of wetlands and on the other had, trying to assess the feasibility of inteNention scenarios to guarantee sustainable development, depends to a very large extent on the availability of reliable and up-to-date information.

This is the more so as the present study has to appreciate the total value of wetland functions in the Pilot Areas and is not limited to a CBA of the proposed inteNentions, which in itself could prove relatively simple as it compares incremental costs with incremental benefits.

The followingdata sources have been used:

1) Existing data in reports and literature (text, figures, graphs, tables; on paper or digital);
2) Existing data in map format (on paper or digital);
3) Expert knowledge;
4) New field data coming from obseNations and inteNiews.

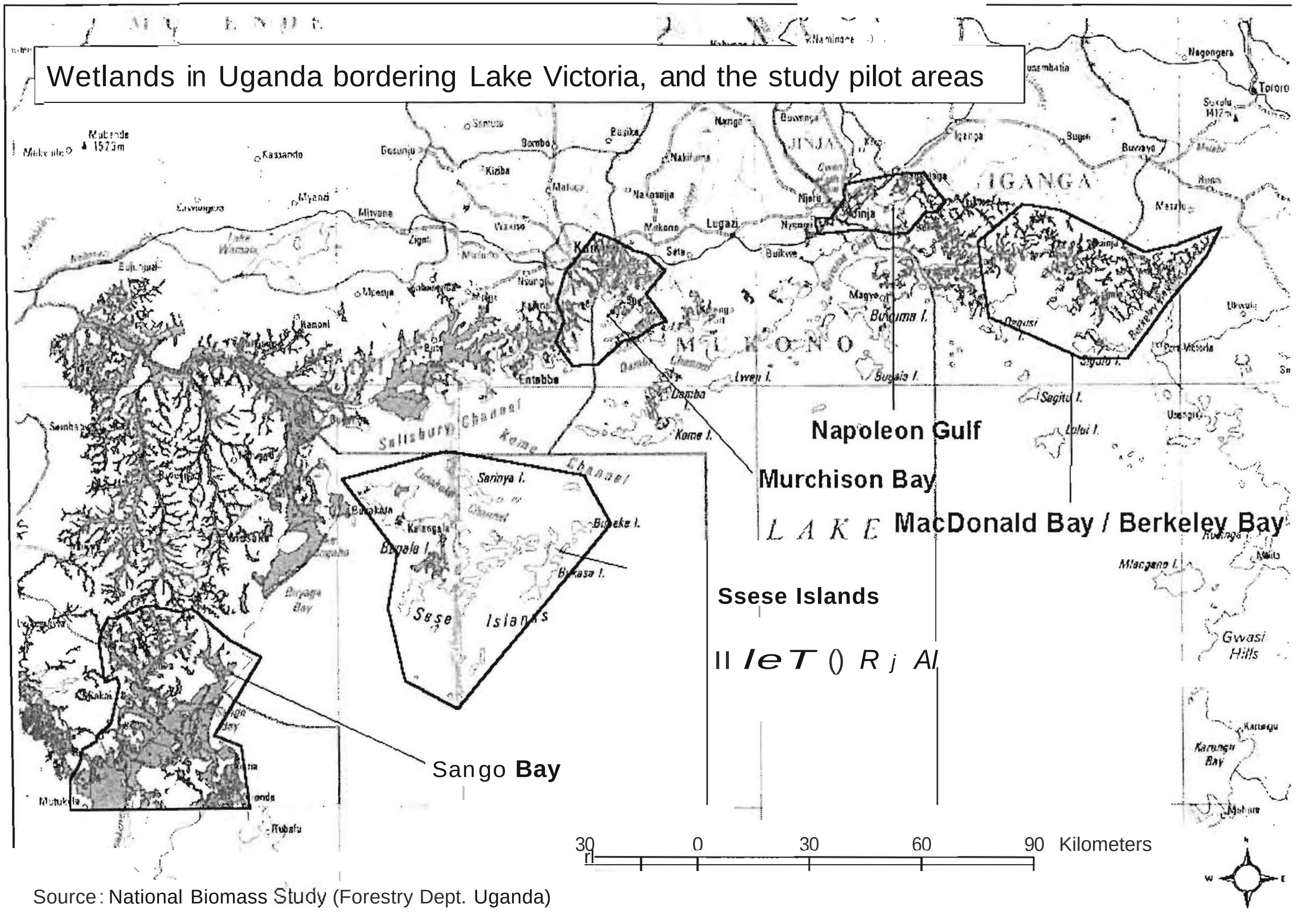


Figure 1.1.1 Location of the pilot areas.

Although wetlands have been in the centre of attention in Uganda for a number of years, it should be underlined that there is a fairly good understanding of the different mechanisms affecting the wellbeing of wetlands, but unfortunately very little is done in the field of systematic data collection.

This implies that for a greater part this study had to create its own database containing newly created data that are based on a combination or on the analysis of data mentioned above.

2 WETLANDS AND THEIR SERVICES

2.1 Wetland services and values

Wetland functions and values can be described from various points of view. In the context of this cost benefit study an economic viewpoint is applied without excluding traditionally non-economic values as biodiversity and social services.

Wetlands consist of a complex system of services and environmental resources and each of them has an economic benefit, although it may not always be easy to estimate its value. Environmental benefits are not all the same, some are the result of economic activities, others have an indirect link with economic activities, while there are also benefits which have no direct economic impact.

The World Bank and many others make a distinction between the use value of a resource and its non-use value. The use value of an environmental resource derives from goods and other benefits that can be extracted from the environment by humans, while the non-use value relates to benefits the environment may provide, but which do not involve using it in any way, whether directly or indirectly.

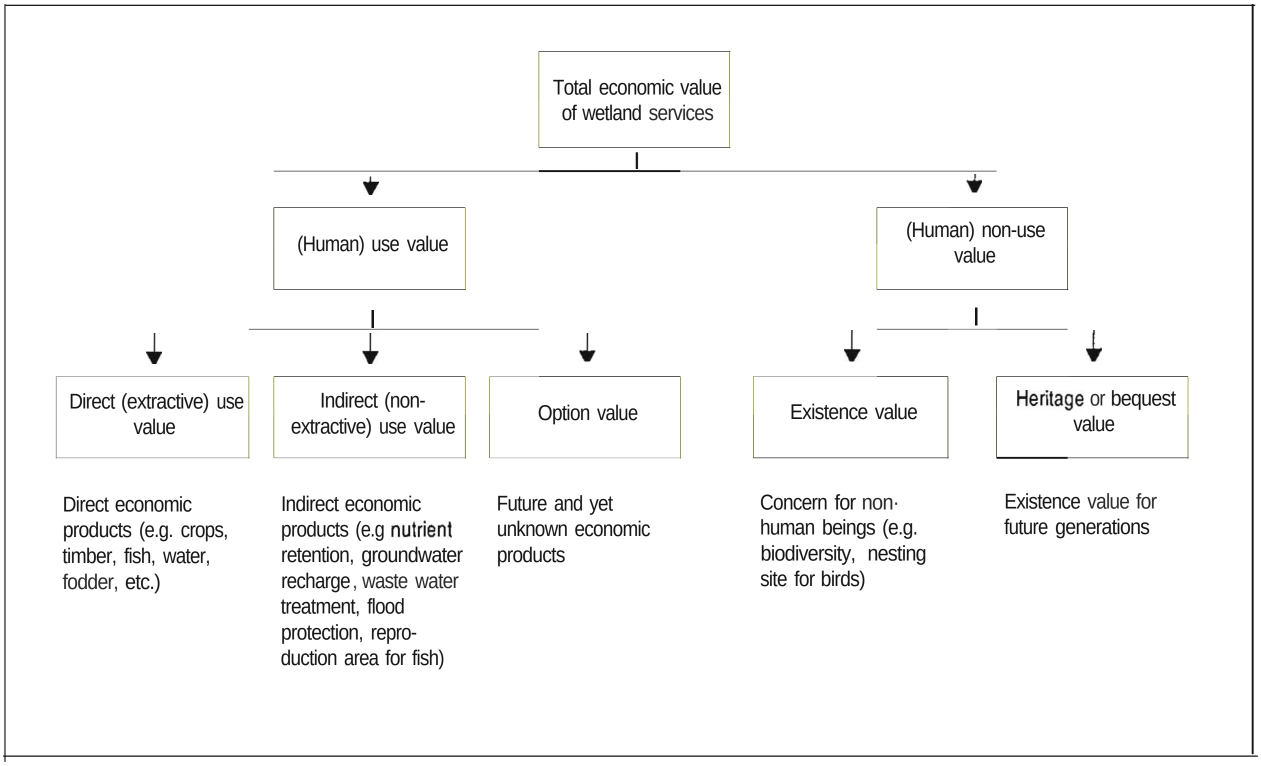


Figure 2.3.1 Possible values of an environmental resource (World Bank, 1998).

The distinction between use and non-use values is an important one as it has consequences for the methods of valuation used as will be explained.

2.2 Identification process of wetland services

Before being able to estimate the (human) use and non-use values, it is necessary to identify them and to retain only the relevant ones. On the basis of wetland literature (e.g. Roggeri, 1995) a list of probable benefits and dis-benefits can be drawn up. This provides a comprehensive <u>inventory</u> <u>of</u> <u>probable</u> <u>benefits</u> (IPB).

The wetlands under consideration are then classified according to their characteristics, resulting in typical wetlands, each having their specific values. Benefits from the IPB can be eliminated if it appears from literature, field studies (rapid surveys, participatory rapid rural appraisals, etc.) and expert knowledge that these benefits cannot accrue from typical wetlands. This process results in a <u>preliminary</u> <u>inventory</u> <u>of</u> <u>benefits</u> (PIB) for a specific wetland.

The process to assess the importance of benefits for the wetland under consideration and thus to draw a PIB, consists of indicating for each probable benefit:

* The level at which the benefit is enjoyed: local, regional, national, international;
* The beneficiaries: the populations as a whole or specific interest groups, rural or urban communities, current population or future generations;
* Whether the importance of the benefit depends on a single wetland or a group of wetlands in the region/ basin: e.g. network of wetlands, each of which lie on the migration route of a wildlife species; combined influence of several wetlands on climatic conditions.

The third step is to create a <u>definitive</u> <u>inventory</u> <u>of</u> <u>benefits</u> (DIB). This inventory is established by taking into account planning and management activities; an important step to consider as they single out certain wetland functions and give them priority over others, within the perspective of national or local planning objectives.

Once the DIB is agreed upon, it becomes imminent to value the benefits of a resource. Valuation of benefits is not easy and demands various techniques, depending on the nature of the benefit. The value of part of the benefits is based on changes in output, some benefits need a cost-based approach (e.g. compensating value), other benefits can only be valued through contingent valuation (e.g. willingness to pay). Then there are those estimated via hedonic pricing (e.g. property values and wage differential) and finally some can only be estimated through a travel-cost method.

The final step (step 5) in valUing benefits consists of drawing up an inventory of the benefits to be maintained: <u>inventory</u> <u>of</u> <u>maintained</u> <u>benefits</u> (1MB) based on three criteria:

1. *Absolute value of each benefit (step 4A):*
   A function or property with a very low benefit may be excluded from the inventory.
2. *Priorities for environmental protection (step 48):*
   Some benefits may be excluded as their environmental importance is not highly ranked or their protection may be in conflict or incompatible with protection of environmental properties considered being more important.
3. *Development objectives (step 4C):*
   Benefits that fall outside the development objectives can be excluded; e.g. when an area will be dedicated to cleaning urban wastewater, for instance, other functions such as clay extraction for brick making may have to disappear, so their benefits can be disregarded.

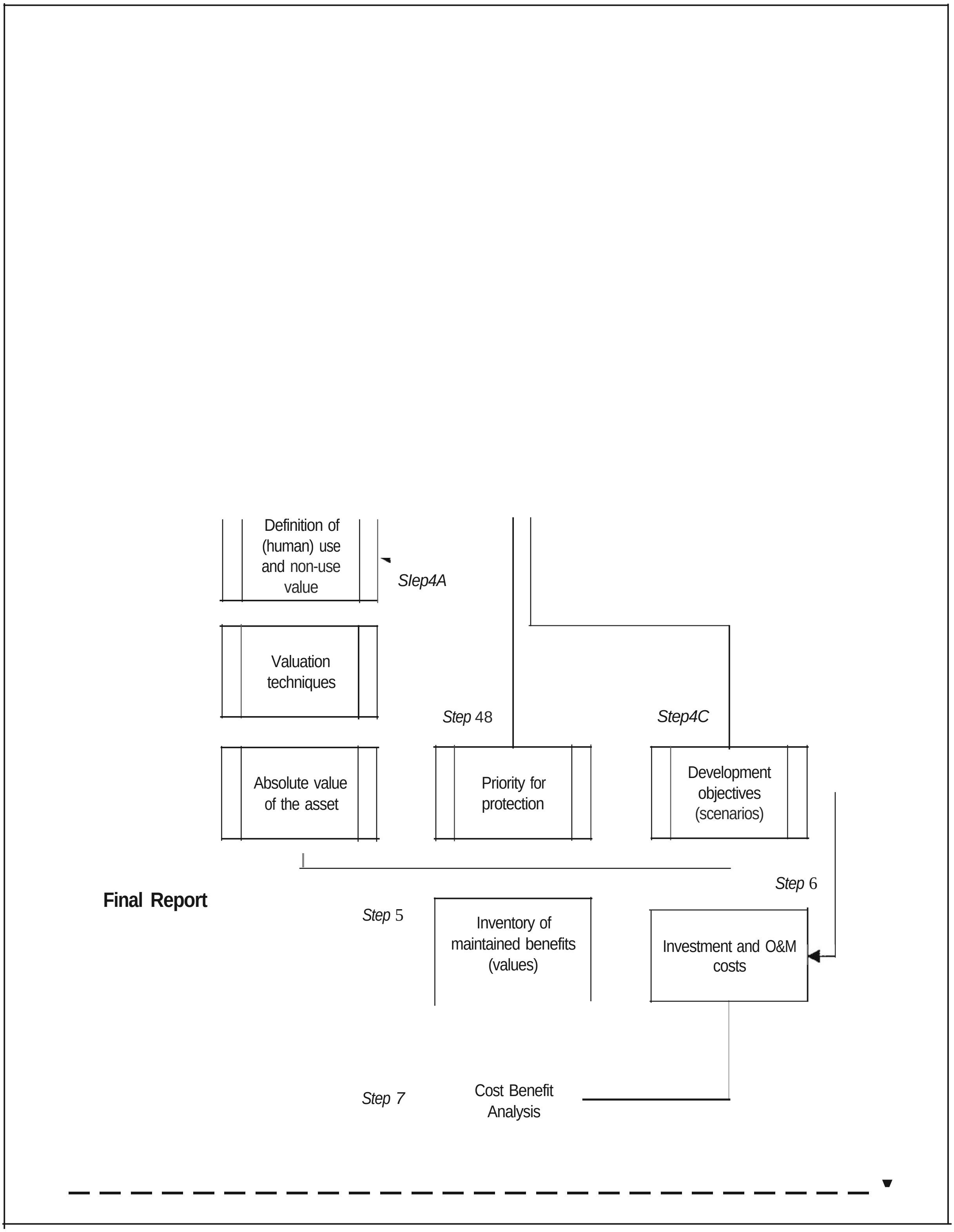


Figure 2.2.1 Steps in defining environmental benefits (adapted from Roggeri, 1995).

The development objectives determine what investments are needed while there are operation and maintenance costs to sustain the intended situation. These expenditures form the cost side of the CSA, while the maintained benefits deliver the benefit side of the CSA (step 7).

The assessment of the economic value of wetland benefits needs some more clarifications. The value as being assessed without any expenditure made to restore them, represents the actual value of the resource; it may be the degraded value as existing in the studied wetlands. The benefits, after restoration, could be different, probably valued at a higher price.

This is exactly what a CSA tries to assess: a comparison of increased benefit values and the costs involved to achieve the increase.

3 APPROACH

3.1 Classification of wetlands

In the five Pilot Areas over one hundred and fifty separate wetlands have been identified and should logically be analysed. However, details of most of these wetlands lack and many wetlands have similar characteristics and opportunities, which opens opportunities for some sort of classification and consequently an analysis per wetland class.

Wetlands have been grouped, so the CSA can be limited to a set of representative wetland areas of each distinguished class. This grouping in classes, based on appropriate classification criteria, should result in a workable number of groups or classes to be analysed. This means that the choice of the classification is a critical one, and it should provide opportunities for valuing wetland products and services and for a CSA of those wetlands where interventions take place.

Since the Ramsar Convention on Wetlands (1971) various classification systems have been introduced, but the wetlands in Uganda, all non-saline, cover only a limited part of the types existing worldwide. Even in Uganda several classifications are being used, but almost all are based on a combination of hydrological characteristics, soil and vegetation types. The following definitions in Table 3.1.1 originate from Roggeri, 1995.

Table 3.1 .1 Typology and characteristics of wetlands that can be found on the Ugandan side of Lake Victoria (Roggeri, 1995).

Wetland complex	Wetland types	Observations
Floodplains	River floodplains Lake floodplains Swamp floodplains Floodplains of small overflow valleys	Periodically flooded, normally completely submerged during the high-water season.
Marshes! swamps	Flooded grasslands Herbaceous swamps Swamps with peat and peal-fanning swamps Headwater swamps	Presence, for a large part of the year, of shallow stagnant waler; marshes and swamps never fully dry out.
Swamp forests	Including flooded forests	Found on the lower shores of water bodies and rivers, in depressions and in some high water riverbeds, on muddy water-logged soils.
Shallow lakes	Including other shallow water bodies	Absence (or low implantation) of emergent vegetation and the presence of submerged plants or plants with floating leaves.

The above classification is difficult to apply in a cost benefit analysis, as it does not reflect the economic value of wetland products and services. For that purpose a more appropriate classification needs to be developed and used in the present study.

3.2 Classes and economic values

It would be logical to base the criteria for classification on values, which are directly related to wetland products and services (see §2.1). On the other hand common practice is to classify wetlands according to their hydrological characteristics, soil and vegetation types. As products/ services and physical characteristics of wetlands are related, the two approaches for classification can be combined without conflicts.

Key of the classification is that only those wetland products/ services and characteristics are chosen as a criterion that lead to a clear distinction between the various wetlands. The following parameters and their related resources seem adequate and practical for the purpose of this study and at the same time relate closely to the existing wetlands database:

1a) *Urban vs. Rural*
The wetlands near the urban agglomerations of Kampala and Jinja suffer from pollution and serve as a filter for the sewage flowing to Lake Victoria. Urban expansion also threatens them, and agricultural use, craft and construction materials extraction is high in these areas. These functions and threats make the urban wetlands distinct from the rural ones.

1b) *Vital or Unique*
A wetland may be considered vital when it provides an essential good or service for which there is no alternative source of supply or the alternative is not practically or economically viable. For example: a town may depend for its drinking water supply on the wetland, the wetland protects a village against flooding or erosion, or the wetland is a religious site. A wetland is unique when that wetland offers something valuable that cannot be found elsewhere (or is very rare). For example: if the Shoebill stork is nesting in a wetland it can be classified as unique. Because of their importance, vital and unique wetlands are considered a separate group.

2) *Lacustrine l Permanentlv wet vs. Riverine l Seasonallv wet*
The wetlands adjacent to Lake Victoria have their hydrological conditions mainly dictated by the lake, with water levels fluctuating within a year and perennially. The wetlands further from the lake, alongside the rivers and streams, have to deal more with swift water fluctuations within the year and may fall completely dry. The hydrological conditions influence the composition of flora and fauna; e.g. the lacustrine and riverine regime each attract specific fish species that use the wetlands for spawning! hatching.

3a) *Forest vs. Papyrus vs. Cvperus dives/ rotunda, Vossia, Miscanthus, Phragmites*
In the permanently flooded wetlands three types of vegetation are found: swamp forest, papyrus as the dominant species and a combination of *Cyperus dives/ rotunda, Vossia, Miscanthus* and *Phragmites.*

3b) *Forest (incl. palms & thickets) vs. Grass vs. Agriculture*
In the seasonally flooded wetlands forest are found (some with palms & thickets as the dominant vegetation), grassland and agriculture land.

For the CBA, values and products/ services have to be defined for all classes in each Pilot Area in order to calculate the total value of wetlands. l\lot all-aforementioned wetland classes are found in each Pilot Area though, e.g. in Napoleon Gulf are no permanently wet forest swamps.

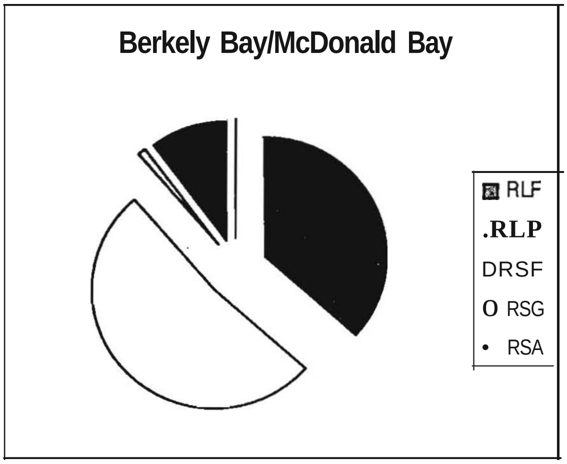
The final classification is based on location, vegetation and land use found in the wetland database, and based on the biomass study, although it proved not always correct being from 1996 and based on data from 1990 and 1993. Supplementary data collected during field visits to Sango Bay, Murchison Bay, Napoleon Gulf and Berkeley/ MacDonald Bay was used to update the classification. Table 3.1.1 provides details of the wetland classes retained for the present study.

Table 3.2.1 Proposed wetland classes.

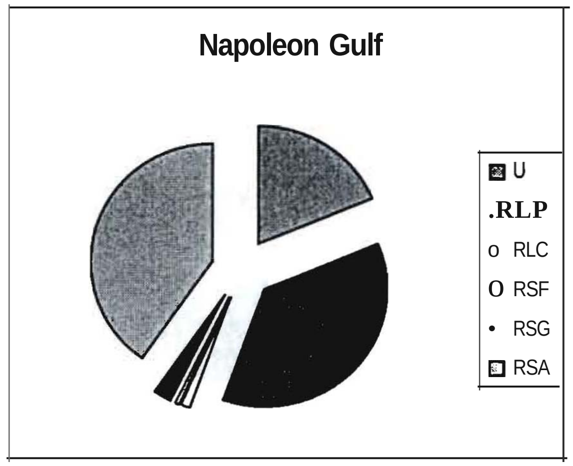
Main characteristic	Hydrological conditions	Dominant vegetation or land use	Code	Distinguishing factors
Urban			U	*Severely polluted, extensively exploited and/or flora and fauna strongly affected, high population pressure*
Rural	Lacustrine or permanently wet	Forest	RLF	*Forest swamp in areas with low population pressure, short-term and perennially fluctuating water levels*
		Papyrus	RLP	*Papyrus swamp in areas with low population pressure, short-term and perennially fluctuating water levels*
		Cyperus dives! rotunda, Vossia, Miscanthus, Phragmites	RLC	*Swamp with mixed, non-ligneous vegetation in areas with low population pressure, short-term and perennially fluctuating water levels*
	Riverine or seasonally wet	Forest (including palms and thickets)	RSF	*Forest in areas with low population pressure, rain water dependant water levels*
		Grass	RSG	*Grassland in areas with low population pressure, rain water dependant water levels*
		Agriculture	RSA	*Wetland where the natural vegetation has been replaced by agriculture in areas with low or medium population pressure, rain water dependant water levels*
Vital or Unique			V	*Exceptional funetion(s) or value(s), preservation required*

The analysis of all wetland areas entered in the database for this study reveals that there is a large variation between the Pilot Areas as to the importance of the various wetland classes. Over all the Pilot Areas riverine wetlands with grass vegetation (RSG) account for 54% of all wetland areas, while the lacustrine wetlands with papyrus (RLP) or mixed vegetation (RLC) and the riverine ones with forests (RSF) cover between 10% and 15% of all wetland areas. Urban wetlands cover only 3% of the total wetland area.

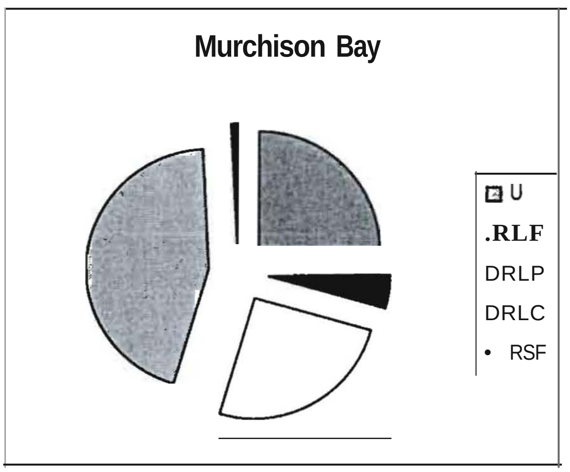
The five figures below give an overview of the distribution of wetland classes for each of the Pilot Areas. Annex I provides details on the wetland area per class and the total number of wetlands in the Pilot Areas.



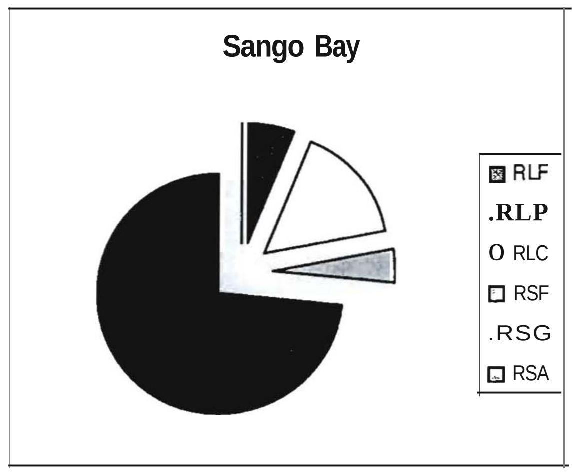
Distribution of wetland classes Berkeley/ MacDonald Bay



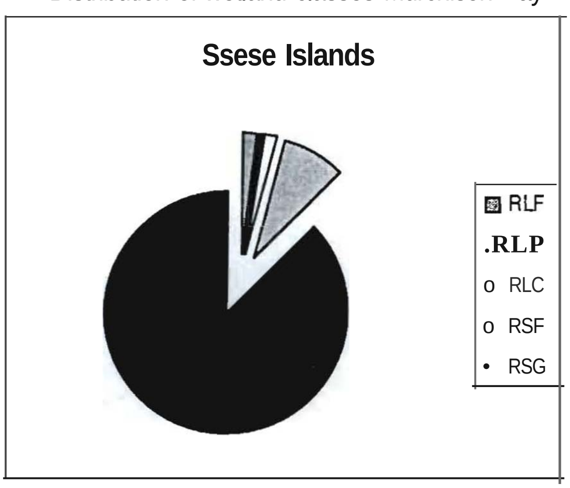
Distribution of wetland classes Napoleon Gulf



Distribution of wetland classes Murchison Bay



Distribution of wetlands classes Sango Bay



Distribution of wetlands classes Ssese Islands

Figure 3.2.1 Distribution of wetland classes in the five Pilot Areas.

4 SOCIAL-ECONOMIC FABRIC

4.1 Stakeholders

Defining the number of persons (stakeholders) making use of the wetlands is a critical issue in the process of identifying and valuing wetland products and services. Because individuals make use of wetlands, these tend to change and as a result some functions expand, often at the cost of other functions.

The estimation of the numbers of stakeholders making use of the various wetland classes is constrained by the lack of detailed information on numbers making use of wetlands. However, from the little that is known about the use of wetlands by individuals, it has been possible to estimate the number of stakeholders.

The available data consisted of the population census 1991 giving figures on Parish level, digital maps of the wetlands, parishes, land and water areas and number of persons likely to make use of Nakivubo wetland.

Murchison Bay, Napoleon Gulf and Berkeley Bay/MacDonald Bay

Based on information found in 'The Present Economic Value of Nakivubo Urban Wetland, Uganda' (Emerton, Sep. 1999) and in the 'Socio-economic Survey of Nakivubo Wetland' (Malachi, Apr. 1999) the estimated number of persons using the wetland in 1991 was about 2,300 persons.

If the population distribution in the Parishes around Nakivubo wetland would be uniform over the area outside and next to the wetland, these 2,300 persons correspond with the number of people living in a 1DO-meter buffer around the wetland.

The wetlands on the northern side of Lake Victoria (including Nakivubo wetland) are in majority dendritic systems, i.e. fringing wetlands following the lakeshore and the rivers upstream. No vast areas of wetland occur in here.

The population lives almost exclusively on the land outside the wetlands. As no details are available, the same principle as used for Nakivubo is followed for the other wetlands on the northern side of Lake Victoria.

The following steps show the way the calculation is done:

1) Around every individual wetland a buffer area of 100 meter wide is selected;
2) From these buffers the area occupied by water and wetland is deducted;
3) Every buffer is split up (in buffer segments) over the Parishes it covers;
4) The relative area (% of the total) that a buffer occupies in these segments is calculated;
5) Assuming an even distribution of the population, the number of people inside a buffer segment is calculated by multiplying the total parish population by the relative area that buffer segments occupy;
6) All buffer segments that belong to the same wetland or cluster of wetlands are joined and the population of these segments are summed.

Sango Bay and Ssese Islands

The wetlands in Sango Bay and on the Ssese Island are different from the ones described above. The pattern of spatial occupation is not dendritic, but areal, i.e. length and width are roughly of the same size.

A considerable part of the population, especially in Sango Bay, lives in or directly adjacent to the seasonally inundated wetlands. The area occupied by the wetlands compared to the area of dry land is also much higher.

It is consequently estimated that the direct use of the wetlands is higher than in the other Pilot Areas. Arbitrarily, it is assumed that the area occupied by wetlands in terms of percentage is representative for the percentage of the population using the wetlands in a direct way.

The following steps show the calculation method:

1) Every wetlands is split up (in wetland segments) over the parishes it covers;
2) The relative area (% of total area) that a wetland segment is occupying is calculated via the GIS;
3) Assuming an even distribution of the population over the wetland and the area outside an estimation is made of the number of people inside a wetland segment;
4) All wetland segments that belong to the same wetland or cluster of wetlands are joined and the populations of these segments are summed.

Once the stakeholders per wetland were defined, an estimation of stakeholders per wetland class could be made. Figure 1.2.1 presents the results; details can also be found in Annex II.

4.2 Land use

The products and services of the wetlands and the defined wetland classes proved too broad for the estimation of wetland values, and therefore an assessment was made of land use per wetland class. This land use covers the following activities:

1. Agricultural cropping
2. Under grass, often used for extensive grazing of cattle
3. Covered by papyrus
4. Covered by forest
5. Under a mixture of vegetation, e.g. *Cyperus dives! rotunda, Vossia, Miscanthus, Phragmites*
6. Used for mining activities, like brick-making and sand mining
7. Open water
8. Habitations, roads, etc.

Existing pUblished data, mainly on urban wetlands, supplemented by field observation of what happens in rural wetlands, forms the basis for the estimation of the land use in each of the Pilot Areas and in the different wetland classes.

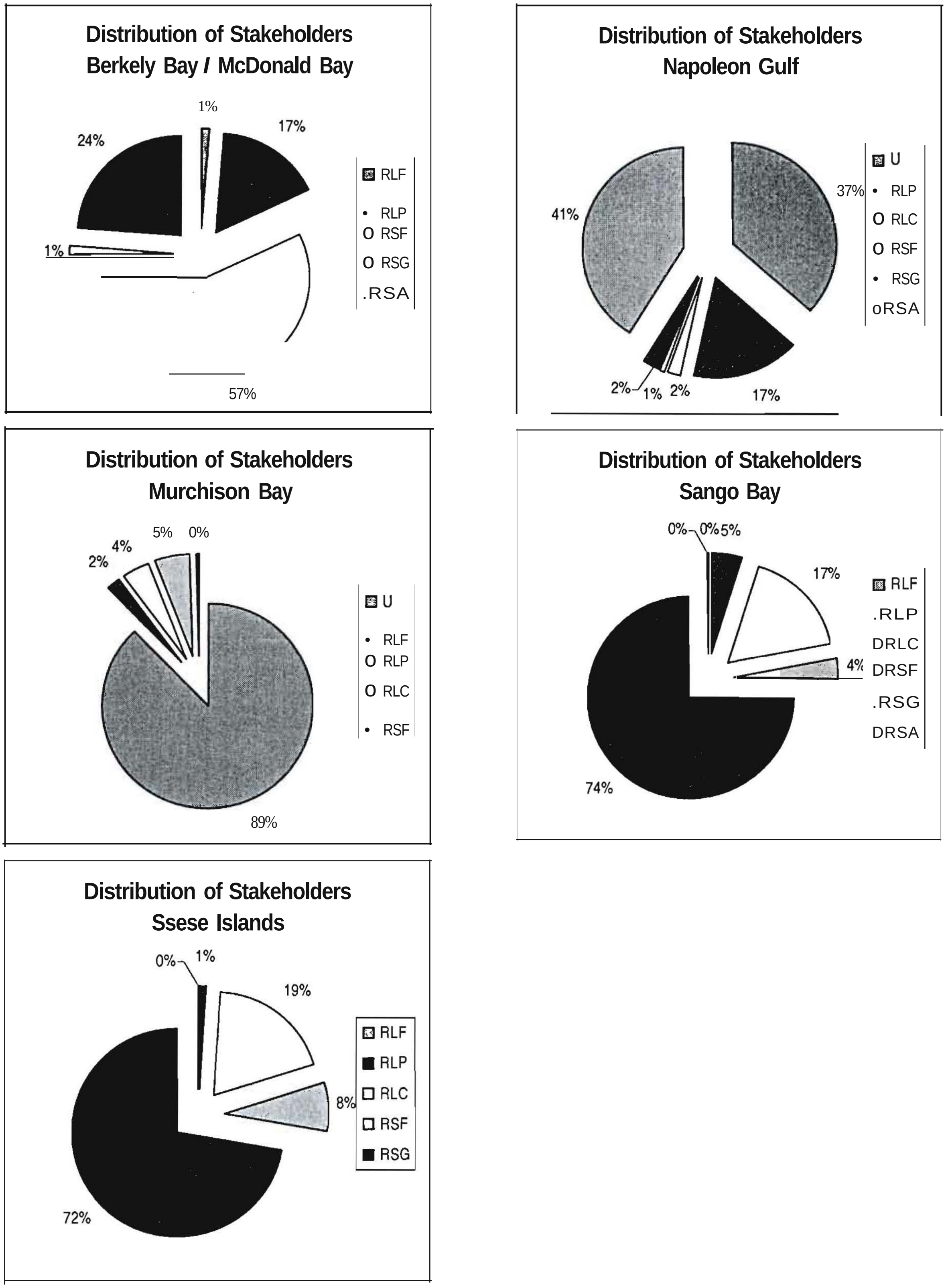


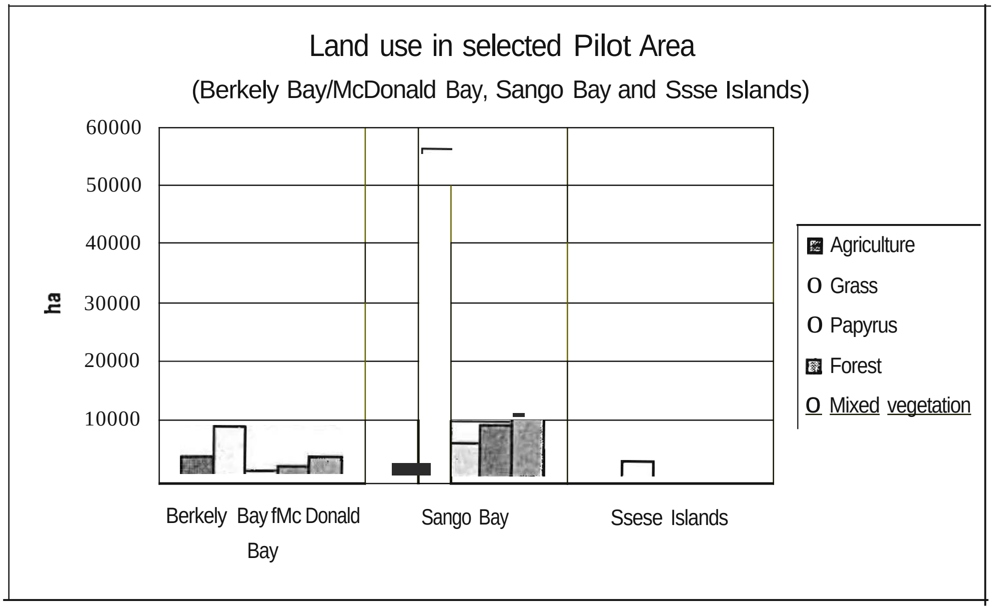
Figure 4.2.1 Distribution of stakeholders in the five Pilot Areas.

During the field visits to each of the Pilot Areas the land use has been estimated for as many wetlands as was possible given the time available. Wetlands are sometimes very extensive systems and in many cases several field observation points had to be taken to obtain a good estimation of the prevailing land use.

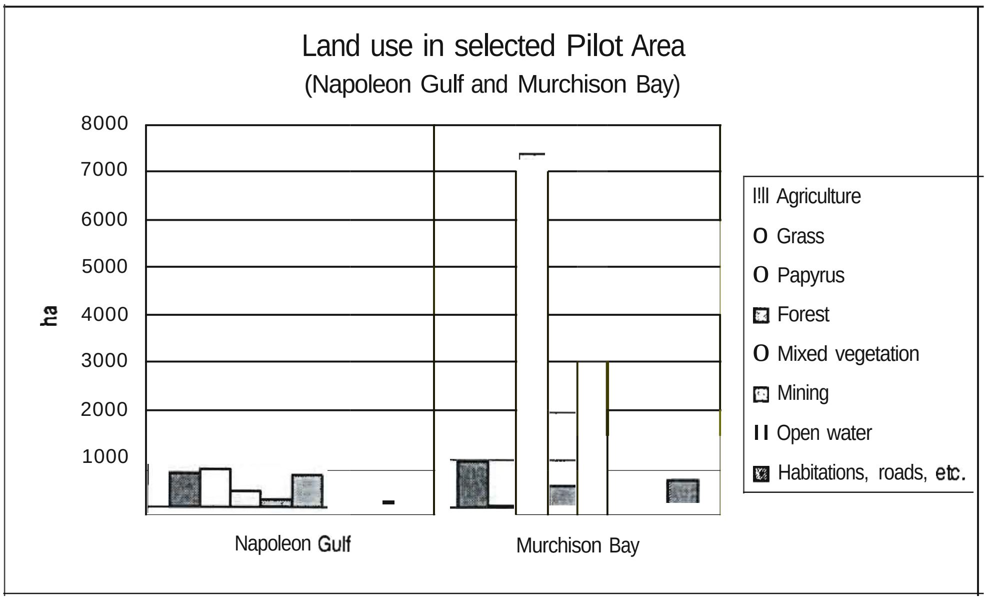
In this manner the land use distribution of a large part of the wetlands in Sango Bay, Berkeley Bay /MacDonald Bay and Murchison Bay has been acquired. The visited wetland classes often cover between 20% and 30% of the total area for the particular wetland class, making the field observation the best possible estimation of land use one could achieve under the present circumstances.

For the wetlands in Napoleon Bay the number of visited wetland classes was much less, except for the urban wetlands in Jinja, which have been studied extensively and to which field visits have been made to collect land use data on site. However, the nature of these wetlands and the prevailing land use in Napoleon Gulf resemble those in MacDonald Bay and Murchison Bay, so that it was considered acceptable to apply the same land use patterns.

The land use of the wetland classes that is published in Annex II is based on these methods of information collection and estimation. The figures below gives an overview for each of the Pilot Area.



(Part 1)



(Part 2)

Figure 4.2.2 Overview of land use in each of the pilot areas.

4.3 Area for fish spawning

Based on a critical analysis of all the wetlands in the Pilot Areas, an assessment has been made of their potential to playa role as fish spawning ground. It appears from the analysis that a large number of wetlands (155 wetlands out of a total of 163) possess this potential.

The distribution of the wetlands over the Pilot Areas and per wetland class is presented in ANNEX IV; in Table 4.3.1 a summary is given.

Table 4.3.1 Potential wetland sizes for fish spawning.

Pilot area	Potential spawning area (ha)
Berkeley Bay *IMacDonald* Bay	18805
Napoleon Gulf	3433
Murchison Bay	11044
Sango Bay	85849
Ssese Islands	4515

5 ECONOMIC VALUE OF WETLAND GOODS AND SERVICES

5.1 Border conditions and assumptions

In this chapter are presented the results of the economic analysis of direct and indirect human use products of the wetlands, such as crop production, water and natural products like papyrus for mats or clay for bricks, and the value of wastewater treatment. The analysis does not consider secondary benefits, like the income derived from the processing of wetland products,like papyrus mats, milling of paddy, etc.

The economic analysis of wetland products endeavours to estimate the financial and economic returns of the human use products from wetlands. The estimation of the value and returns of these human use products, when they are sold on a market, is rather simple and often consists of an analysis of the various cost and benefit items of an economic activity (cropping, use of natural products, etc.).

However, products that are not directly sold on a market are somewhat more difficult to value, which is the case with water for instance. In cases like this shadow pricing and willingness-to-pay could provide a method of valuation.

The financial analysis estimates the returns for the stakeholders of wetlands, while the economic analysis looks at advantages for the country as a whole.

The analysis of costs and benefits makes use of market prices in the financial analysis and economic prices or opportunity costs for the economic analysis. Economic prices can either be derived from market prices or else estimated through a border price analysis. When deriving economic prices from market prices, conversion factors are used to estimate the economic value of goods and services from the prevailing market price

As few of the wetland products are traded on the international market, a border price analysis becomes useless and the estimation of economic opportunity costs is derived from local market prices by using conversion factors. For all locally traded goods and non-use benefits a Standard Conversion Factor (SCF) is used to change market and financial values into economic values. This SCF is estimated at 0.85 for Uganda, based on the analysis presented in the table below.

Table 6.3.1 Calculation of the Standard Conversion Factor for Uganda.

Foreign trade (US$ mln)		1993/94	1994/95	1995/96	1996/97	1997/98	1998199	Average
Imports	M	702	1080	1230	1246	1 411	1337	1168
Exports	X	265	595	591	671	458	549	522
Import duties	Tml	138	204	240	257	232	219	215
Sales tax on imports	Tm2	49	80	95	NA	126	138	97
Subsidies on imports	Tm3	-	-	-	·	-	-	-
Exports duties	Tx	·	15	13	3	0	0	5
SCF=(M+XY(M+Tml +Tm2-Tm3+X-Tx) =		0.85						

Source. MFPED, 1999, Background 10 the Budgel1999/2000

For the estimation of labour costs it is not possible to use the SCF because it would not reflect employment characteristics in Uganda. In view of the prevailing unemployment, it would be more realistic to apply a conversion factor (called Shadow Wage Rate or SWR) of 0.75 to estimate economic wages from the on-going market rate[1].

There is a distinct difference between the cost of labour near urban centres and in the rural areas. The standard wage in Kampala and urban areas is USh 2,500 per day, while the wage rate in rural areas is only USh 1,500 per day (see APC, 1998/99 for the rural wage rate).

When observing cropping in wetlands it appears that farmers mix crops and cultivate next to each other crops in one field. The conclusion is that the relevance of mono cropping is low in wetlands except for those wetlands that have fallen prone to estate cultivation of sugar, oil palm, etc, and consequently the economic analysis evaluates cropping systems.

The economic value of all natural products harvested from the wetlands is considered to equal returns on harvesting of raw materials[2], meaning that for *Papyrus* the returns on harvesting bundles of stalks defines the economic value. The same would apply to other natural products like leaves from *Phoenix palms,* medicinal plants, etc.

With respect to cropping the analysis uses the hectare as the unit for calculation of revenues. The analysis of natural product use, like papyrus and *Phoenix* palm, uses where possible the hectare, but it makes corrections for the low usage of the area. In brick making, the analysis results in the revenue per production cycle.

5.2 Wetland cultivation

Characteristics

From the field observations it appears that there are similarities in wetland cropping systems. For instance in Berkeley Bay/ MacDonald Bay there are two types of wetland cropping systems. The first system is one with maize as the predominant crop that is mainly cultivated in the dryer parts of wetlands. The second system relates to the production of rice in the wetter parts of wetlands.

The pattern that exists in Nakivubo wetland is also twofold: cocoyam is the predominant crop in the wetter parts and a system with staple food crops combined with vegetable production is found in the dryer parts of the wetland.

In the rural wetlands of Murchison Bay the cocoyam system is also found and also vegetable production in combination with staple food crops is found in these wetlands. In the urban wetlands of Jinja, a similar combination of systems as in Nakivubo wetland is found.

1 Having little economic basis to substantiate the SWR, the factor for Bangladesh has been used, a country also having a high unemployment ratio.

2 This approach is fully warranted as the processing of natural products is comparable to the processing of agricultural produce (e.g. the milling of rice) and would be part of the spin-off to the economy. For agricultural produce this spin-off is not considered and hence it should not be considered for natural products either.

The prices of produce and those of inputs are taken from the report published by the Agricultural Policy Committee (APC, *1998/99)* and from the publication on Nakivubo wetland (see Emerton e.a., 1999)

For those produce wherefore no price was published in these two reports, it has been assumed that the farm-gate price in urban wetlands equals 60% of the urban market price as published in the newspapers in Kampala. Moreover, it is estimated that the farm-gate price in rural wetlands is 70% of the farm-gate price in urban wetlands.

Budgets and distribution

The crop system budgets from the various sources that are discussed above are presented in ANNEX V.

The results as shown in the annex have been used to calculate the economic value of wetland cropping in the following way:

1. The cropping system bUdgets for urban wetlands apply only to urban wetlands, which are solely found Napoleon Gulf and Murchison Bay (see ANNEX I).
2. The Cocoyam - Sugarcane system (urban) is expected to prevail on 75% of the cropped surface in these wetlands.
3. The Staple foodcrops - Vegetables system (urban) applies to only 25% of the agricultural surface in urban wetlands.
4. In the Napoleon Gulf, Murchison Bay, Sango Bay and Ssese Islands Pilot Areas, 75% of the lacustrine and 25% of the riverine wetlands agricultural areas are under the Cocoyam - Sugarcane system (rural).
5. In the same pilot areas, 25% of the lacustrine and 75% of the riverine wetlands agricultural areas are cropped with the Vegetable - Stable foodcrops system
6. In the Berkeley Bay IMacDonald Bay Pilot Area, Maize - Stable foodcrops systems cover 50% of the lacustrine wetlands and 75% of the riverine wetlands.
7. The Rice cropping system applies to 50% of the lacustrine wetlands and 25% of the riverine ones in the same Pilot Area

Conclusions

In combination with the land use data published in ANNEX III this gives the following results of wetland cropping systems and their importance over the five Pilot Areas.

Table 5.2.1 Distribution of cropping systems and income from farming activities.

Pilot Area	Cropping System	Type of wet-land	Area (ha)	Income (In million USh)	
				Financial (before labour)	Economic (alter labour)
Berkeley BaylMacDonald Bay	Maize-Staple foodcrops	Lacustrine	921	517	315
		Riverine	1416	795	485
	Rice	Lacustrine	921	960	660
		Riverine	472	492	338
	Sub-lolal		3730	2764	1799
Napoleon Gulf	Cocoyam - Sugarcane (U)	Urban	58	122	91
	Staple foodcrops-Vegetables (U)	Urban	19	40	27
	Cocoyam-Sugarcane (R)	Lacustrine	197	276	209
		Riverine	86	121	91
	Vegetables-Staple foodcrops (R)	Lacustrine	66	108	78
		Riverine	258	425	308
	Sub-total		685	1091	806
Murchison Bay	Cocoyam - Sugarcane (U)	Urban	522	1097	820
	Staple foodcrops-Vegetables (U)	Urban	174	363	246
	Cocoyam-Sugarcane (R)	Lacustrine	160	224	170
		Riverine	5	6	5
	Vegetables-Staple foodcrops (R)	Lacustrine	53	88	64
		Riverine	14	22	16
	Sub-total		928	1800	1320
Sango Bay	Cocoyam-Sugarcane (R)	Lacustrine	1285	1799	1363
		Riverine	289	405	307
	Vegetables-Staple foodcrops (R)	Lacustrine	428	703	511
		Riverine	868	1 192	1425
	Sub-total		2870	4332	3215
Ssese Islands	Cocoyam-Sugarcane (R)	Lacustrine	-	-	-
		Riverine	54	76	58
	Vegetables-Staple foodcrops (R)	Lacustrine	-	-	-
		Riverine	163	267	194
	Sub-total		217	343	251

It is difficult to predict what will happen to wetland cropping if no actions are taken to limit its expansion, probably leading to a reduction of areas that are now under natural vegetation. However, it would not be unrealistic to estimate the growth of wetland cropping at 2.5%, which is more or less the average population growth in Uganda.

5.3 Use of natural vegetation

5.3.1 Papyrus

Characteristics

Papyrus is extensively used as roofing material and as raw material for the production of papyrus mats. However, only papyrus stalks are considered in the economic evaluation of wetland products, as this is what the wetland produces. The income gained from the processing of papyrus stalks should not be seen as forming part of the direct benefits of wetlands, it is a secondary benefit.

Papyrus harvesting takes only place in a small part of the wetland area covered by papyrus because large parts of the area can only be accessed by boat. From field observations and from published documents it appears that only about 10% of the area is harvested in urban wetlands. In rural wetlands it has been observed that the harvested area is even smaller, being estimated at only 2% of the area covered by papyrus.

BUdgets and distribution

Based on field observations in Jinja and the publication about the economic values of Nakivubo wetland in Kampala (Emerton *et al,* 1999), an estimation was made of the return of papyrus harvesting in urban and rural wetlands. The results are published in ANNEX VI.

It should be noted that although the net returns (after labour) are negative in financial and economic terms, the reward per labour-day is positive, yet lower than the prevailing wage rate.

Conclusion

In combination with the land use data published in ANNEX III this gives the following results of the harvesting of papyrus and its importance over the five Pilot Areas.

Table 5.3.1 Distribution of income from papyrus harvesting.

Pilot Area	Type of wetland	Area (ha)	Income (In million USh)	
			Financial (before labour)	Economic (after labour)
Berkeley Bay/ MacDonald Bay	Rural	1332	29.3	-0.6
Napoleon Gulf	Urban	128	19.2	-4.1
	Rural	208	4.6	-0.1
	Sub-total	336	23.7	-4.2
Murchison Bay	Urban	1528	229.1	-48.7
	Rural	5903	129.9	-2.5
	Sub-total	7430	359.0	-51.2
Sango Bay	Rural	6032	132.7	-2.6
Ssese Islands	Rural	49	1.1	0.0

5.3.2 Phoenix palm

Characteristics

Phoenix palms are found mainly in the mixed vegetation wetlands in most of the Pilot Areas, except in Sango Bay, where they are common in the forest wetlands.

The population is cutting down palms to make poles, which are sold on the road site to truck drivers who sell them in the urban centres. Needless to say that trees are destroyed with the risk of depletion of a wetland product.

Based on field observations and on information received from the Jinja District Office, an estimation was made of the economic value of this wetland product.

Budgets and distribution

The estimation of the financial and economic returns of Phoenix poles assumes that harvesting takes place in only 10% of the mixed vegetation wetlands in Berkeley Bay/ MacDonald Bay, Napoleon Gulf, Murchison Bay and Ssese Islands, as well as in 10% of the forested wetlands in Sango Bay.

The budget that is based on this assumption and on the information collected is presented in ANNEX VI.

Conclusion

This budget, in combination with the land use data published in ANNEX III gives the following income for the harvesting of Phoenix poles and its importance over the five Pilot Areas.

Table 5.3.2 Distribution of income from Phoenix poles harvesting.

Pilot Area	Type of wetland	Area (hal	Income (In million USh)	
			Financial (before labour)	Economic (after labour)
Berkeley Bay/ MacDonald Bay	Mixed vegetation	3920	4.1	2.2
Napoleon Gulf	Mixed vegetation	507	0.5	0.3
Murchison Bay	Mixed vegetation	2697	2.8	1.5
Sango Bay	Forest	9158	9.6	5.1
Ssese Islands	Mixed vegetation	291	0.3	0.2

5.3.3 Grazing and fodder production

Large parts of the wetlands are covered in grass, on which herdsmen graze their cattle. In particular this happens in Sango Bay, where grassland covers about two third of the total wetland area.

Grazing on these lands is extensive and returns are not very high. However, cattle herding is an economic activity tied to wetlands and should thus be evaluated.

In the next version this will be done.

5.3.4 Other products

Wetlands are providing wood for burning and as construction material, but its importance is not very large. It is estimated that only 10% of the forested wetlands are prone to the extraction of timber and firewood.

Based on field observations and information from the District Office in Jinga, it is estimated that the financial income before labour costs are deducted equals USh 11 per ha wetland, while the economic income (after deducting labour costs) is USh 7 per ha.

ANNEX VI provides details.

Wetlands are also a source of medicinal plants and herbs, but very often the source of these products is not limited to wetlands. Forests are the most important areas for medicinal plants in Africa and wetlands are not considered important as a source, except maybe for a few specific plants, which are only found in wetlands.

Consequently, it looks as if medicinal plants and herbs collection from wetlands can be ignored.

5.4 Use of fauna

5.4.1 Fish catches

Various fish species live in permanent wetlands, but their economic value is small as the nearness of Lake Victoria, being more productive in terms of non-wetland species, makes that fishermen prefer to fish in the lake. Consequently, the value of fishery in the wetland can be ignored.

However, wetlands are important for the reproduction of fish. This non-use value is discussed and valued in Paragraph 5.9.

5.4.2 Game

From field observation it appears that the shooting of wild animals happens, but that its importance is low. Moreover, there are little or not details known. Consequently, no attempt has been made to evaluate this activity.

5.5 Water

Characteristics

Wetlands are considered an important source of domestic water for the population living in their vicinity and having no other means of securing their basic water needs. On the basis of a number of assumptions the price of domestic water from wetlands can be estimated.

These assumptions are:

1. The totality of the stakeholders depends on the wetland for their water consumption: in §4.1 an estimation has been presented of the number of stakeholders making use of wetlands in the five Pilot Areas.
2. The daily consumption per person is 10 litres, which is considered the basic minimum need for a person each day.
3. The average family size in rural areas is 5.5 (APC, 1998/99)
4. Water is normally carried to the household in 20 litre plastic jerrycans and one person can carry one jerrycan per trip.
5. Water points are located about 3 km from the houses, each trip taking 2 hours.
6. The average wage rate in rural areas is USh 1,500 per day, while the economic price of labour is only 75% of the financial rate (see §5.1).

Based these assumptions, the collecting 55 litres of water per day per family demands an effort equal to USh 1,031 in foregone wages, as persons have to spent time on water collection and cannot do any other paid employment.

However, the value of the water collection effort could need some modification, as it does not represent in total foregone wages. Many studies have shown that water collection is a social event, especially for women as it offers them the opportunity to leave the house and socialise with other women, to exchange news, etc.

Moreover, it has been observed in the field that persons collecting water take the opportunity to collect for instance some cocoyams for the next meal or they collect burning materials.

For how much the social and other activities account is difficult to assess, but they carry a price. Because water catching is probably combined at least two or three other activities, it seems reasonable to allocate only one third of the foregone wage to the collection of domestic water, one third to the social component and one third to side activities like collection of food and burning material.

Willingness-la-pay

From the above it can be calculated that the effort put into water collection equals USh 6.25 per litre water when 55 litres per household is fetched. The value in economic terms is 75% of this (because of the SWR conversion factor of 0.75). This figure nears the water price of around USh 4 per litre paid to vendors in rural areas.

Moreover, there is the price elasticity for the consumption of water, which give the relationship between consumption and price (= the effort one is prepared to put into the collection of water). This price elasticity is -0.30 for water consumption, meaning that a 100% price increase would lead to a 30% reduction in consumption.

These two elements permit to construct a simple demand curve for rural wetland water consumption, which is presented in the next figure. The curve gives the relation between the water price, in terms of effort one is prepared to pay and the level of consumption per family. The more scarce water becomes the higher the price (effort).

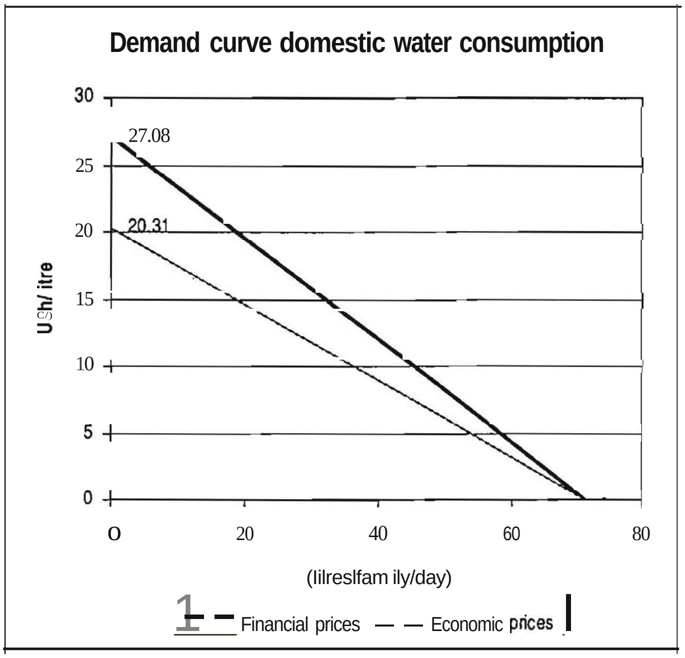


Figure 5.5.1 Demand curve for wetland water consumption.

The economic theory defines the price of water as the surface of the triangle under the demand curve and calls it the willingness-to-pay (WTP).

Conclusions

The WTP for water from wetlands, as following from the demand curve is estimated at USh 14 per litre water at financial prices, which equals USh 10 in economic terms. With these values and the number of stakeholders, it is possible to make an estimation of the value of water consumption from the wetlands in the five Pilot Areas. Table 5.5.1 provides details.

Table 5.5.1 Estimation of the value of water consumption.

Pilot Area	Stakeholders	Consumption (m^3/year)	Financial values (In USh '000)	Economic values (In USh '000)
Berkeley BaylMacDonald Bay	31886	116384	1629	1164
Napoleon Gulf	18195	66410	930	664
Murchison Bay	89127	325315	4554	3253
Sango Bay	76074	277 670	3887	2777
Ssese Islands	2552	9315	130	93

5.6 Mining

5.6.1 Brick making

Characteristics

Brick making takes place in wetlands as well as outside wetlands, making it difficult to judge its economic value. However, from field observations it seems warranted to estimate that brick making in wetland areas is mainly taking place in the Murchison Bay Pilot Area, focussing urban wetlands.

The brick kiln in urban wetlands are larger than the ones in rural wetlands. The urban kiln produce about 15,000 bricks per cycle, of which 13,000 are fit to be sold. Kilns in rural wetlands are smaller, containing some 3,000 bricks of which 2,600 can be sold.

It seems that the number of months per kiln production cycle is 1.5 and with a total production period of 8 months, this amounts to 5 kiln firing cycles per year. The area mined for brick making per year is estimated at one hectare.

In urban wetlands brick kilns are fired with wood brought in by trucks from outside the wetland, while this is not the case in rural wetlands, where firewood is collected from the surrounding natural vegetation. However, in order to (shadow) price this collection of firewood, the analysis costs firewood at the same price as for urban wetlands.

The financial and economic analysis is furthermore founded on field observations and a IUCN publication concerning brick making activities in Mukono District (IUCN, 1996) and the economic value of Nakivubo wetland (Emerton *et al, 1999).*

Budgets and distribution

ANNEX VII provide details of the budgets for brick making in urban and rural wetlands. Based on the land use distribution (see ANNEX III) discussed earlier, it appears that brick making only takes place in the wetlands around Murchison Bay

Conclusion

Combining the production budgets for urban and rural wetlands with the land use distribution gives the total economic value of brick making, which is reproduced in the table below.

Table 5.6.1 Distribution of income from brick-making in wetlands.

Pilot Area	Type of wetland	Area (ha)	Income (In million USh)	
			Financial (before labour)	Economic (after labour)
Murchison Bay	Urban	55	170	82
	Rural	13	4	1
	Sub-total	68	174	83

5.6.2 Other mining products

It is known that wetlands are sources of sand for construction and also clay is mined for making pottery. However, the importance of these activities seems little in economic terms. In the next version economic aspects will be looked at in more detail.

5.7 Other direct human use values

Apart from the direct human use values discussed in the preceding paragraphs, there are other services which wetlands provide, some are beneficial to human beings, others are not.

Possible positive services that wetlands could provide are transport and tourism. The first does not seem very important in the wetlands covered by the five Pilot Areas and is thus ignored.

A study on eco-tourism done by Makerere University in Kampala with respect to the potential in Sango Bay showed that at the present stage tourist development is possible, yet on a very limited scale. Consequently, the economic value of eco-tourism can be ignored.

The most important direct use dis-benefit that come from wetlands are the health risks. In particular vectors are finding in wetlands an ideal breeding place and malaria and bilharzia vectors are likely to profit from wetlands nearby.

Finally, wetlands could be a habitat for dangerous and annoying animals like snakes, hippos, monkeys and birds that eat and destroy crops. These dis-benefits have not been assessed in the report, but could be included in the next version if data are available.

5.8 Waste water treatment

Characteristics

Wetlands contain an important potential for treating wastewater, although this potential needs to be exploited and reinforced in the few cases where sewerage is discharged in wetlands.

Five wetlands in Uganda play an important role as collection basin for raw and pre-treated sewerage, notably Nakivubo and Luzira wetlands in Kampala, and Kirinya wetland in Jinja, Nabajjuzi wetland in Masaka and Namkweke wetland in Mbale. Of these wetlands only two lay in the Pilot Areas considered by the study.

From the study on water quality it appears that the effluent discharges in the two wetlands covered by this study are important and also that the wastewater treatment potential of the wetlands, if well managed, would exceed the loads discharged today.

From a recent PhD thesis on the potential of using constructed wetlands for treatment of wastewater (Tom Okia Okurut, 2000), it appears that *Cyperus papyrus* and *Phragmites mauritianus* possess the ability to remove COD, BOD and TIS. Up to 350 kg per day per ha of COD, 100 kg per ha per day of BOD and 150 kg per ha per day of TSS can be removed by a wetland colonised by these two plant species.

When estimating the wetland values in terms of their wastewater treatment potential, the followed approach concentrates on the removal of BOD and compares this with what it would cost to remove the same amount through a conventional wastewater treatment installation.

Nakivubo wetland measures 506 ha and is covered for about 20% with papyrus (101 ha). The inflow of BOD is estimated at 7,000 kg per day of which an estimated 50% is removed actually by the wetland vegetation.

In Kirinya wetland, which measures only 78 ha *Cyperus papyrus* and *Phragmites mauritianus* cover 35% and 30% of the wetland respectively. Today the effluent load to entering the wetland is about 150 kg BOD per day of which an estimated 80% is removed by the wetland vegetation.

Budget and distribution

Based on the criteria and cost given by the earlier mentioned PhD thesis an estimation was made of the cost of removal of 1 tonne of BOD through a conventional waste stabilisation installation of three ponds (anaerobic, facultative and maturation) for a population equivalent of 4,000.

ANNEX VIII provides details of the calculation.

The characteristics of both wetlands show that annually approximately 1,278 tonnes of BOD are removed by Nakivubo wetland. For Kirinya wetland the quantity is much lower and amounts to 43.5 tonnes of BOD per year.

Conclusion

Based on the quantities removed by the wetlands and on the costs of removal, it is estimated that both wetlands have an advantage in the form of foregone constructing and operation costs of a wastewater treatment installation. Table 5.8.1 provides the results.

Table 5.8.1 Value of defence expenditure towards wetland wastewater treatment

Pilot Area	Pollution load (tonne BOD/year)	Removed by wetland	Financial values (In million USh)	Economic values (In million USh)
Napoleon Gulf	54	80%	17	10
Murchison Bay	2555	50%	496	286

5.9 Fish reproduction

Analysis of catches in Berkeley Bay

Wetlands are important for the reproduction of certain fish species *like Protopterus, Clarias, Schilbe, Labeo and Alestes spp.* and part of *Oreochromis niloticus*[3]. However, in some of the pilot areas the spawning grounds for fish species that reproduces in wetlands are under threat as result of the ever-progressing encroachment by men.

3 *Oreochromis niloticus* or Tilapia spawns near the shoreline, not necessarily in wetlands, hence is assumed that 50% of the catch of this species is influenced by reproduction in a wetland environment.

The estimations of the likely value of wetlands for fish production uses data from two pilot areas, for which catch data are available. The catches at four landing sites in Berkeley Bay have been recorded over the period 1993 to 1999 inclusive, while at three fish landing point in Napoleon Gulf data exist for the period 1997 to 1999 inclusive.

Technical data sheet presenting the catches for the landing sites in Berkeley Bay and Napoleon Gulf are presented in Annex II.

The results from Berkeley Bay indicate that total fresh and cured[4] fish landings, including species that do not spawn in wetlands vary between 150 and 450 tonnes (or 150,000 and 450,000 kg) over the period under consideration. A trend analysis of these data show that annually total landings seems to increase with 31.9 tonnes per year.

When looking at those species that spawn in the wetlands of Berkeley Bay, Figure 5.9.1 shows that catches fluctuate between 20,000 and 60,000 kg (or 20 and 60 tonne) over the period 1993 to 1999. The trend analysis of the recorded catches indicates a decrease of landing with 2,607 kg per year, or 6% of the average landed in the recording period.

Some critical notes need to be voiced with respect to these data series:

1. There is much smuggling of fish from Uganda to Kenya: estimations ranges from 50% to 75% of the total catch being exported illegally to Kenya.
2. The use of destructive fishing gear (mini-sized mesh nets, including beach seines) that destroys in particular young fish is prohibited but enforcement is difficult and has seemly limited effect in Berkeley Bay.

Analysis of catches in Napoleon Gulf

The length of the survey period of the catches is much shorter for Napoleon Bay, meaning that the conclusions of a trend analysis have to be viewed more cautiously.

Over the three for which landing were recorded total catches of fish including species that do not spawn in wetlands fluctuated between 300 and 800 tonnes (300,000 and 800,000 kg). When a trend analysis is carries out over this very short period it would seem that catches decrease with 210 tonnes annually.

Catches of fish species that spawn in the wetlands of Napoleon Gulf varies between 10,000 and 25,000 kg (or 10 and 25 tonnes). When looking at the trend over the three recording years it seems that catches would go down with 4,444 kg annually, which is dramatic if true.

In Figure 5.9.2 the fluctuations in catches are presented. In view of the very short recording period the outcome of the trend analysis seems hardly realistic, although the fluctuation in catches shows some resemblance with the curve for Berkeley Bay (see Figure 5.9.1). This phenomena opens opportunities for an estimation of the annual reduction of catches of wetland species, making use of the trend analysis of Berkeley Bay.

4 Smoked or sun-dried fish.

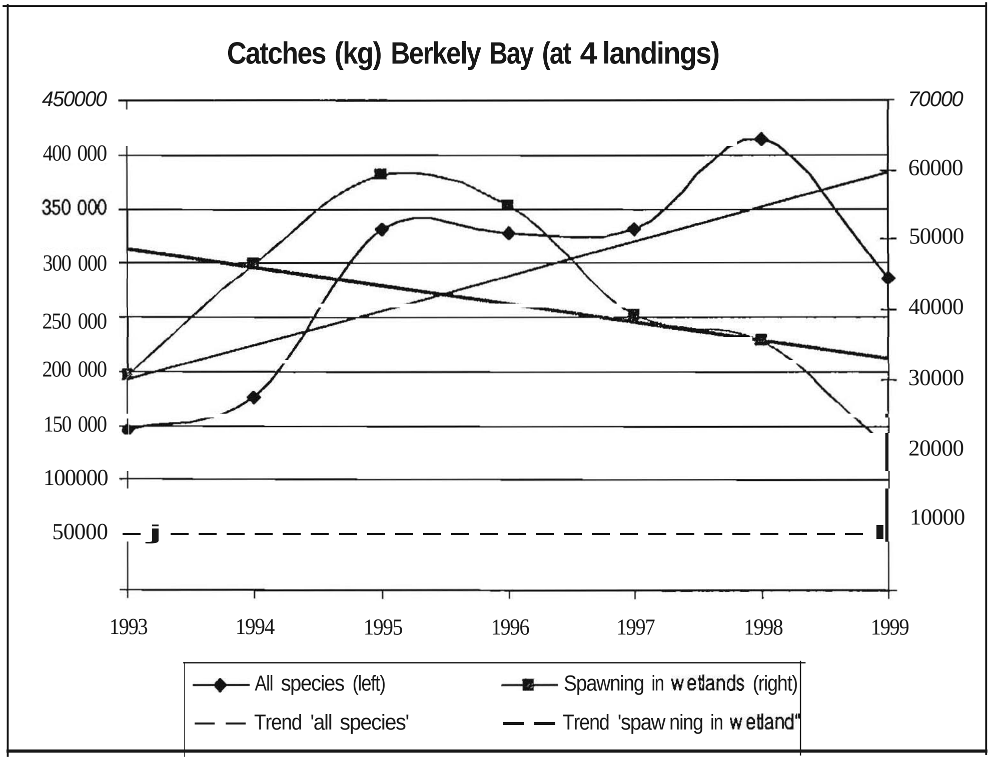


Figure 5.9.1 Fish catches in Berkeley Bay.

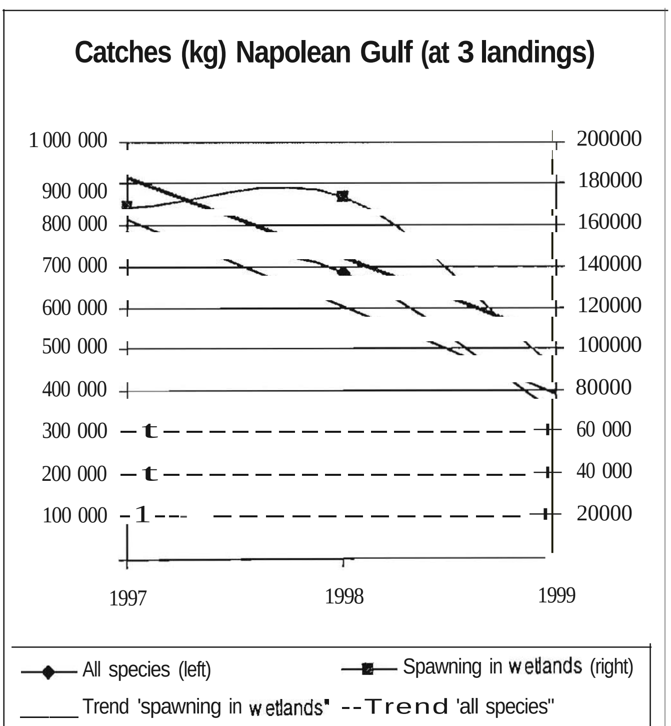


Figure 5.9.2 Fish catches in Napoleon Gulf.

In Figure 5.9.3 the catches of wetland spawning species for both pilot areas are brought together in one picture and fluctuations as recorded in Berkeley Bay have been copied for Napoleon Gulf and presented in the figure. Having no other basis to estimate the fluctuations in Napoleon Gulf it is acceptable to expect that the same annual reductions take place in both pilot areas.

The result of this type of analysis shows that the annual decrease in catches of wetland spawning species in Berkeley Bay is of the order of 6% and in Napoleon Gulf the same reductions is applied.

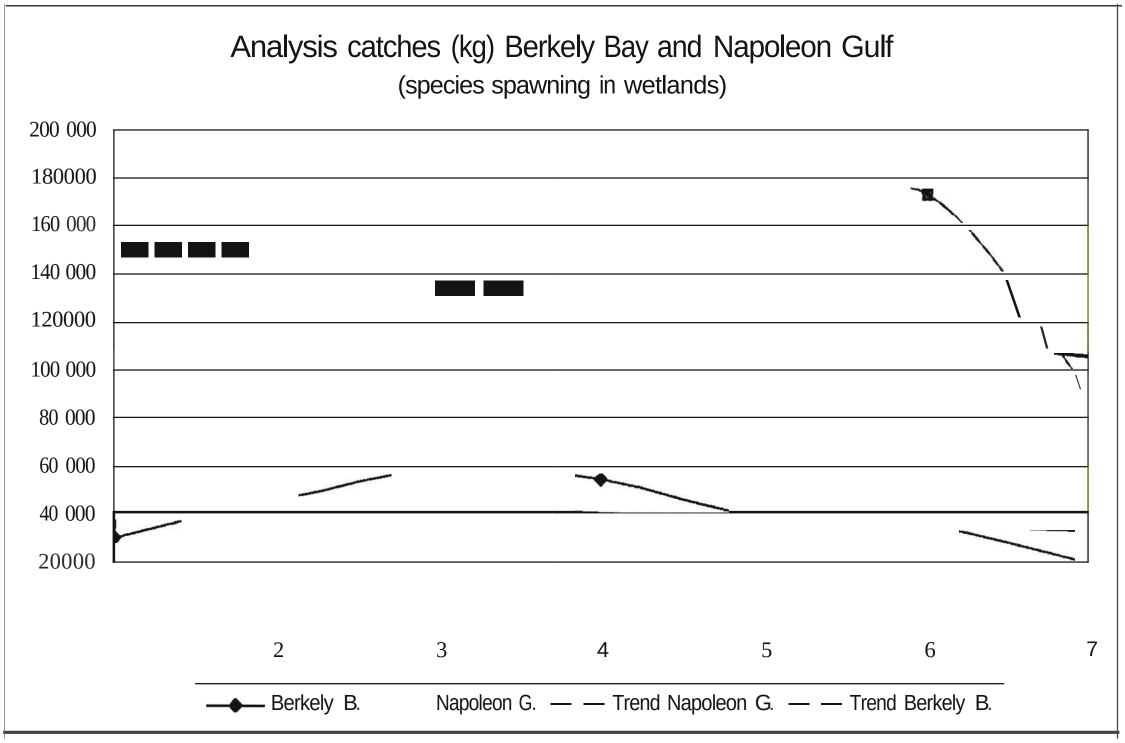


Figure 5.9.3 Analysis of catches in Berkeley Bay and Napoleon Gulf.

In addition to the estimation of production and the likely changes in these, also an analysis has been made of the productivity of wetlands. For each of the landing places all relevant wetlands where fish could spawn have been identified and their area measured.

In the Berkeley Bay area the total surface of wetlands where fish are spawning is estimated at 6,590 ha, while in Napoleon Gulf the wetland surface amounts to 2,206 ha. This means that a hectare of wetland represents an annual commercial production of 5.0 kg in Berkeley Bay and 47.6 kg in Napoleon Gulf.

When a corrections is made for the volume smuggled to Kenya from Berkeley Bay, being between 50% and 75% of total catch, then the productivity of wetlands would be somewhere between 10.0 kg/ha and 15.0 kg/ha. This figure seems realistic in view of the use of destructive gear in this pilot area.

Prices

The records of fish landings in Berkeley Bay and Napoleon Gulf also provide values of the landed fresh and cured fish. In Berkeley Bay a substantial quantity of fish is cured before being marketed. Around Napoleon Gulf little curing takes place, as there are ample opportunities for marketing fish fresh.

The unit prices (per kg) of cured and fresh fish are at the same level: per kilogram the price is somewhere between USh 750 and 1,000. But, because for one kilogram of cured fish one needs three kilograms of fresh fish, the average price of fish (in fresh fish equivalents) is lower in Berkeley Bay, than in Napoleon Gulf.

Table 5.9.1 Prices and marketed quantities of fish in Berkeley Bay and Napoleon Gulf.

Pilot Area	Average price (1997-1999) (UShlkg)	Average quantity sold (kg)
Berkeley Bay	294	342,985
Napoleon Gulf	858	323,476

Nole. The average quantity sold for Berkeley Bay has nol been corrected for the Illegal exports to Kenya.

Catch models and distribution

Based on field observations and on the record of the number of canoes operating in the Busia area, a simple production model has been made for fish catching units. The following assumptions are used:

1) Each fish catching unit consists of 3 persons, 1 boat (24 ft) with outboard motor (5HP).
2) The number of nets per fishing unit in Napoleon Bay: 4 gill nets (1 net of 4.5; 2 nets of 6 and 1 net of 7 inch mesh size).
3) In Berkeley Bay still prohibited cast nets and seine nets are used, each fishing unit has one of each.
4) Per fishing unit about 1 tonne of fish is caught every month.
5) Per fortnight fishermen work approximately for 10 days, the other days are used for rest or are lost due to bad weather, etc.

Annex IV provides details and shows that the returns are much higher in Napoleon Gulf than in Berkeley Bay, which is the likely result of the fact that in Napoleon Bay almost all fish is sold fresh, while in Berkeley Bay a large share of the catch is cured.

In view of the fact that part of the pilot areas have a more rural character than others, which are more urbanised, one may expect that the conditions of Berkeley Bay would apply to the more rural wetlands and those of Napoleon Gulf to the urbanised ones.

Under the present circumstances it seems therefore, logic to assume that in three of the five Pilot Areas, notably Berkeley Bay! MacDonald Bay, Sango Bay and Ssese Islands, the values as defined for Berkeley Bay apply. Under a "business as usual" scenario the following conditions would apply:

1. Each hectare of wetland where fish spawns represents a commercial catch of 20.0 kg.
2. The annual decrease of this catch is estimated at 6%.
3. Average prices in 1999 values for fresh fish are estimated at USh 294 per kg.

The present situation as found in Napoleon Gulf would be representative for two of the five Pilot Areas studied, especially the more urbanised ones like Napoleon Gulf and Murchison Bay. The conditions that apply to these wetlands under a "business as usual" scenario are:

1. Each hectare of wetland where fish spawns represents a commercial catch of 47.6 kg.
2. The annual decrease of this catch is estimated at 6%.
3. Average prices in 1999 values for fresh fish are estimated at USh 858 per kg.

Conclusions

Based on an analysis of the wetland areas playing a role in the reproduction of fish species that spawn in wetlands an estimate has been made of the fish production depending on these wetlands. Subsequently, the production figures have been converted in fish catching units.

Table 5.9.2 Estimation of production potential from wetlands and fishing units.

Pilot Area	Potential spawning area (ha)	Reference reproduction (kglha)	Total production (kg)	Catch per fishing unit (kg/year)	Number of units operational
Berkeley Bay/ MacDonald Bay	18805	20	377 257	12000	31.4
Napoleon Gulf	3433	48	163506	12000	13.6
Murchison Bay	11044	48	525963	12000	43.8
Sango Bay	85849	20	1 722251	12 000	143.5
Ssese Islands	4515	20	90575	12000	7.5

After defining the number of fishing units operational in the various Pilot Areas, it becomes possible to estimate the income in financial and economic terms from the budget published in ANNEX IX. The following table gives the results.

Table 5.9.3 Estimation of the value of wetlands for spawning.

Pilot Area	Number of units operational	Income (In million USh)	
		Financial (before labour)	Economic (after labour)
Berkeley Bay/ MacDonald Bay	31.4	48	13
Napoleon Gulf	13.6	113	76
Murchison Bay	43.8	363	244
Sango Bay	143.5	219	61
Ssese Islands	7.5	12	3

5.10 Other in-direct use values

Protection against flooding (to be done);
Recreation (can be ignored).

5.11 Summary of human use wetland values

Combining all the direct and indirect use values identified for the wetlands in the five Pilot Areas gives the following results. Comparison of the financial and economic values is not directly possible.

The financial results indicate the cash income from wetlands without costing labour. As most labour used is family labour, the financial value gives the cash raised in wetlands.

The economic value presented here is a "true" economic value. The labour cost involved in acquiring wetland products and services have been costed at their opportunity cost and the results show the economic income of the products and services.

ANNEX X provides all details of the human use values of the wetlands in the five Pilot Areas. The tables and figures below provide details per Pilot Area and per product/service. The data indicate that the total cash value of wetland products and services equals in financial terms USh 23,464 million. The value per ha wetland reaches USh 187,300.

Table 5.11.1 Summary of human use wetland values per Pilot Area.

PiiolArea	Values (In Million USh)	
	Financial (before labour)	Economic (after labour)
Berkeley BaylMacDonald Bay	4472	2976
Napoleon Gulf	2175	1551
Murchison Bay	7749	5136
Sango Bay	8581	6055
Ssese Islands	486	348
TOTAL	23464	16066
Value par ha wetland (USh '000)	187.3	128.2

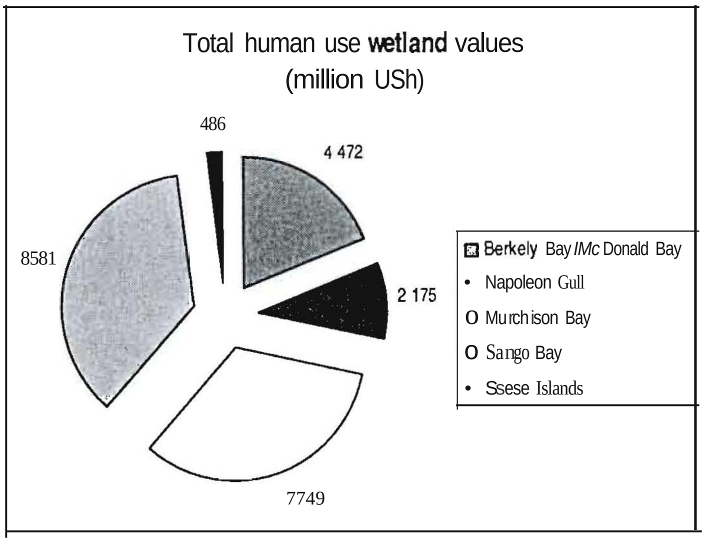


Figure 5.11.1 Summary of human use wetland values per Pilot Area.

Table 5.11.2 Summary of human use wetland values per product! service.

Product/service	Values (In Million USh)	
	Financial (before labour)	Economic (after labour)
Crop production	10331	7391
Papyrus harvesting	546	-59
Phoenix poles	14	8
Timber and lirewood	0	0
Brick-making	174	83
Domestic water	11 131	7951
Wastewater treatment	513	296
Fish reproduction	754	397
TOTAL	23464	16066

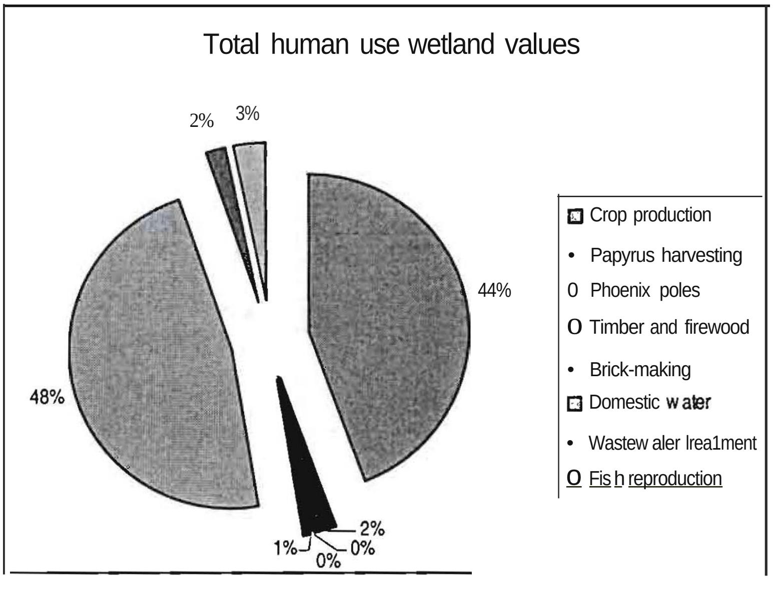


Figure 5.11.2 Summary of human use wetland values per product! service.

The financial value of the wetland products and services identified in this chapter also represents the added value at market prices, as it concerns revenues minus cash expenditure, which also equals labour plus profit. However, to compare this figure with the national accounts for Uganda, the value in market prices should be converted to a value at factor costs.

As one single conversion factor (SCF of 0.85) is used for all goods and services, this factor can also be used to convert the added value in market prices to added value at factor cost. Using the conversion factor means that the added value at factor costs, in 1999/2000-values equals USh 19,944 million.

From the data provided by the Ministry of Planning and Economic Development (MPED, June 2000, Background to the Budget 2000/01) the national product (added value at factor cost) for the agricultural sector was USh 4,157,699 million in 1999/2000. Wetland products and services in the Five Pilot Areas represent only 0.5% of this value.

However, whenever the value of wetland products and services is divided by the estimated number of stakeholders in the five Pilot Areas (217,834), this gives a per capita wetland GOP of USh 9,156, which is 2.2% of the per capita GOP for the whole country.

6 VALUING NON-USE WETLAND FUNCTIONS

6.1 Valuation techniques

Contingent valuation is the method for estimating the value of the existence and bequest value of wetlands, meaning that one tries to assess how much a popUlation or country is willing to pay for maintaining certain wetland functions.

This is a rather complex analysis, which is already difficult with persons having a clear notion of what environment is and what its contribution is in the lifecycle of human beings and plant or animal species. Not to speak of persons for whom the natural environment is something so obvious and natural to their life.

Nature has always surrounded them and has always been an integral part of their life, as has been the sun for everybody else. Asking how much one is prepared to pay for keeping, what they consider a gift of God or nature, is somewhat strange and probably yields non-realistic values.

Added to this comes the fact that those using wetlands to make a living often belong to the poorest, having the least opportunities in society. The only place to go, where there are still space and opportunities are often wetlands.

Moreover time *is* often a constraint in the execution of contingent valuation or other techniques (travel cost method, hedonic pricing) to value the willingness-to-pay or the willingness-to-accept.

This means that other indicators have to be found, which shed a light on the value a country or individuals attach to wetland functions. The following discussion CQuid provide an indication of what a country or individuals are willing to pay for wetland functions and values and their protection or sustainable use:

When looking at the price societies or individuals are prepared to pay for the preservation of an environmental (non-use) good, a distinction has to be made between social costs, those incurred by society, and individual costs.

The social costs accepted by a society are possibly reflected by the expenditure made towards environmental protection and restoration. Individual costs made for protection the environment have to be found there where a person is prepared to pay a premium to buy something that is less damaging to the environment.

Social costs:

1. The wetland part of NEMA's expenses minus revenues;
2. The wetland part of the Ministry of Water, Lands and Environment's expenses minus revenues;
3. The wetland part in the local council's and city council's expenses minus revenues;
4. The local cost of Uganda counterparts and debt servicing in the various wetlands' projects (LVEMP, NWP, etc.);
5. The cost of enforcing wetland programmes;
6. The cost of advertising and awareness raising on radio and television;
7. The local component of expenses for wetland research and teaching (NARO, Makerere University, etc.).

Individual costs:

1. Price differentials between wetland products and non-wetland alternatives and their use;
2. Extra costs, outside those already accounted for in the production models, made by individuals or communities for sustaining certain wetland functions, e.g. stopping of hunting to protect wildlife stocks, banning fishing during certain periods to allow reproduction;
3. Attendance and time spent on wetland functions' awareness raising campaigns;
4. Transaction costs, being a real cost to the environment or a disbenefit. It covers all actions by individuals to counter prohibitive environmental rules and regulations.

However, some criticism needs to be voiced as to the choice of these elements. The true economic value is reflected by the optimal use of a resource and not by spillage or waste. In this respect it may be so that the Ugandan society as a whole or individuals are prepared to spend money on the protection of wetlands through the national budget or individual expenses. However, it remains unclear whether this money yields the expected results, and if it was used in the most efficient manner.

Moreover, it is recognised that budget expenses are not only targeted to the non-use functions of wetlands; they could also pertain to use functions, like protecting fish resources, sustainable use of food and medicines as well as craft products, etc. This makes these costs redundant for the valuation of the non-use functions.

As there is probably a strong linkage between use and non-use functions (degradation in biodiversity is linked to e.g. sustainable craft material use, fish stocks, food or medicinal plant resources), it could be argued that the cost of maintaining use functions are in fact social costs towards maintaining non-use functions.

Moreover; because these protection costs are not imputed directly in individual production functions they are likely to reflect the social cost or willingness-to-pay for maintaining non-use functions.

In the next version estimations will be made of the non-use values of wetlands, using the method presented here.

7 COST BENEFIT ANALYSIS OF WETLAND DEVELOPMENT SCENARIOS

7.1 Sustainability criterion

An important aspect in developing and proposing interventions for wetlands is the so called "sustainability criterion", which implies that as much as possible wetland functions should be preserved or restored. Hence, the interventions should target typical wetland functions as for instance the ability to treat wastewater, to retain nutrient, to produce typical wetland products, to provide a spawning ground for fish, etc.

Whether one should preserve such functions as the ability to produce crops, to let graze animals, to produce timber and firewood or yet to provide domestic water is debatable as these are not typical wetland functions. But one should mind that wetlands could playa role in recharging groundwater aquifers, or they could be important in the protection against floods.

Natural vegetation plays a role in flood protection, and it is this very function that needs protection. Whether natural vegetation also provides as a product firewood and timber could be important in economic sense, but would be less important in functional sustainability terms (unless depletion takes place affecting the flood protection function).

With respect to the non-use functions of wetland, the sustainability criterion becomes more important, as too little is known of the exact cause effect relationships between some of the non-use functions and their impact on human use functions. Here the sustainability criterion would emphasis the protection and restoration of important non-use functions: biodiversity, role in lifecycle of species, maintenance of integrity and stability of ecotone and related ecosystems.

7.2 Development scenarios

The Wetland Sector Strategic Plan 2001 - 2010' categorises wetlands according its importance and status. Their 'importance' involves, dispensable, valuable, and vital; 'status' can be, threatened, not threatened, and destroyed. The document briefly states the strategy for management, as summarised by the following table.

Table 7.2.1 Strategy for management with respect to individual wetlands (Wetland Sector Strategic Plan 2001 - 2010).

		Status		
		Threatened	*Not threatened*	*Destroyed*
Importance	*Vital*	Restore	Monitor strictly	Restore
	Valuable	Ensure wise use	Monitor	Restore
	Dispensable	Encourage wise use	Monitor	Ignore for the time being

Combining these strategy options with the wetland classification established in volume I (Ch. 4), a number of scenarios for management and development of wetlands have been defined in order to obtain a sustainable situation. These scenarios are outlined for each wetland class.

The selected scenarios are within the reach of realisation under given legal, political and socio-economic circumstances. At least for all indispensable (vital, valuable) wetlands monitoring is advised in order to remain up-to-date on their status and developments.

Scenario 1: No intervention

For both urban and rural wetlands the basis scenario is 'no intervention'. This means that current developments in wetlands are not further steered by the environmental agencies of central or local government and left to the initiative of the public, private companies or other government agencies.

In part of the wetlands that means that the ecological functions will decline in favour of human activities (agriculture, industry), whereas in some rural wetlands a stable situation exists.

Scenario 2: Preservation of the current situation

The second scenario for urban and rural wetlands is maintaining the current situation, the 'status quo'. The environmental agencies of central or local government try to maintain in this case the actual land use and processes taking place.

In some cases that requires active involvement, like in wetlands subject to continuous change (with or without human intervention), while the static wetlands may be left without any governmental involvement to maintain the 'status quo'. For a vital or unique wetland with its essential function(s) still intact this may also be an option.

Scenario 3: Mix: - restoration of natural flora & fauna in some areas;
- agriculture/ extraction of other products in dedicated areas.

Scenario 3 distinguishes two mixed options: one for urban and one for rural wetlands. In the urban wetlands the wastewater treatment will be optimised, whereas in the rural wetlands the main aim will be to protect flora and fauna. At the same time the extraction of products (agriculture, craft materials etc.) may be allowed in dedicated and controlled zones, subject to existing management plans, gUidelines and legal requirements.

For each wetland a viable balance has to been found between the two. This scenario demands active involvement of the government in most cases to adjust the current land use; only some static and well-balanced rural wetlands can be left untouched.

Scenario 4) Optimisation for waste water treatment or optimisation for a wetlands unique or vital function/ value

The highest level of interaction is required by scenario 4. In urban wetlands it implies the optimisation for the cleaning capacity of a wetland, e.g. by fully restoring its natural vegetation or by the creation of supporting civil works.

In vitali unique wetlands the function or value that gives a wetland its *vitali* unique character is optimised. In some cases this will be the biodiversity, in other cases it may be its importance for floodwater retention or retardation (preventing flooding).

ANNEX XI provides a summary of the wetland scenarios proposed

7.3 CBA model for the analysis of individual wetlands

The remaining paragraphs of this chapter gives attention to the second evaluation method, whereby an appreciation should be made of the investment cost and compared with the additional benefits that are achieved.

In ANNEX XII is presented a general approach that is valid for the CSA of individual wetlands, which contains the following characteristics:

* The analysis makes a comparison between two situations, notably the status of a wetland after interventions have been made is compared with the present status and its continuation without any intervention,
* An important element of the analysis concems the sustainability criterion which defines that wetland present functions should continue to be provided in quantity and quality as to satisfy actual and future individual and social demands,
* Evaluation period used in CSA is a function of the economic life of the interventions proposed, although standard practice is to extend the analysis over a period of 25 years being more or less equal to the life of physical investments,
* As result of the intervention wetland function could alter, some function will be reinforced and thus give additional benefits, while other functions will diminish or be lost, resulting in a reduction benefits,
* Wetland functions can either have an economic human use value or they have a non-use value being in fact a value perceived by the community as a whole (social value) or a willingness-to-pay,
* Interventions entail expenses for institutional changes as well as those related to physical and technical layouts,
* The object of the cost benefit analysis is to compare incremental benefits with the costs of interventions and in order to be feasible the first should exceed the latter.

ANNEX XII provides the general model for the CSA of individual wetlands. It presents a general approach that is valid for the CSA of individual wetlands which contains the following characteristics:

* The analysis makes a comparison between two situations, notably the status of a wetland after interventions have been made is compared with the present status and its continuation without any intervention,
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* Wetland functions can either have an economic human use value or they have a non-use value being in fact a value perceived by the community as a whole (social value) or a willingness-to-pay,
* Interventions entail expenses for institutional changes as well as those related to physical and technical layouts,
* The object of the cost benefit analysis is to compare incremental benefits with the costs of interventions and in order to be feasible the first should exceed the latter.

7.4 CBA of urban wetlands

Characteristics

Urban wetlands are specific in so far that they are surrounded by urban infrastructures and face the threats from over-exploitation and destruction by the population living around the wetland.

Many urban wetlands are slowly swallowed by urbanisation and their functions are being marginalised. Taking Nakivubo swamp in Kampala as a benchmark gives the following wetland values:

Table 7.4.1 Human use values of Nakivubo wetland.

Economic human use values	Social non-use values
Crop production	Bio-diversity
Natural flora products: food and medicines, craft materials, energy products, fodder	Uniqueness, rarity, naturalness and aesthetics
Natural fauna products: fish, game	Value for future generations
Mining products: sand and clay for bricks, pottery, etc.	
Water: irrigation water for crop production	
Wastewaler treatment	
Protection against flooding	
Recreation: eca-tourism	

Urban wetlands are likely to degrade considerably when no intervention takes place, thus reducing the economic returns from the various human values these wetlands possess.

The losses in human use values over the project evaluation period have to be taken into account and should be compared to the gains or stabilisation of economic use value when some sort of intervention takes place.

How much the gain in non-use values would be when some sort of intervention takes place is difficult to assess. The rapid degradation of urban wetlands also impacts on the non-use functions these wetlands have whenever the present situation continues and what needs to be assessed is after how many years the functions is completely lost.

The non-use functions of urban wetlands must be safeguarded, as results of the interventions that take place, at least that should be the objective under the sustainability criterion.

The next figure gives the likely developments over the project period, although it only provides a possible evolution it shows clearly that the gap between the situations with and without intervention is widening over the years.

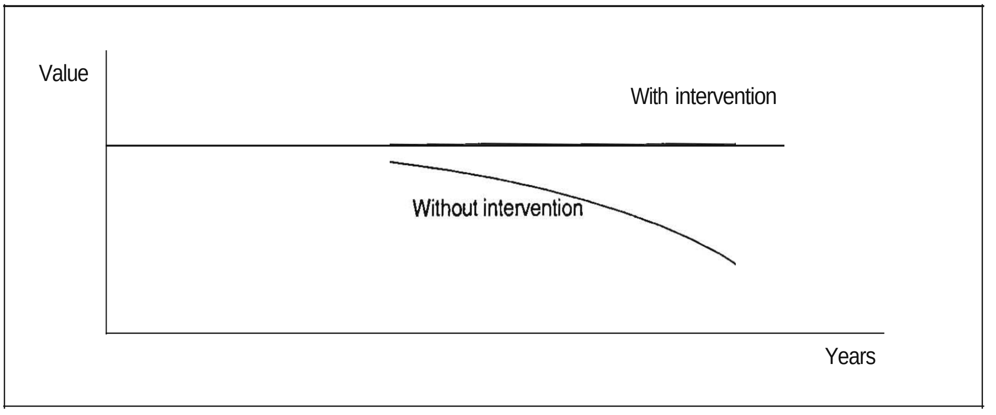


Figure 7.4.1 Likely evolution of non-use wetland functions.

ANNEX XII gives the model for the CSA of urban wetlands

Valuation techniques

The principle for valuing economic use products and services of wetlands has already been discussed and applied in Paragraph 5.1.

What is important for the CSA is the fact that only "incrementals" are valued. This means that difference between the "with" and the 'without" intervention situation are addressed, all other products and functions which remain unchanged are ignored.

Costs of intervention

The costs of possible interventions that would sustain wetland functions are either institutional or physical. It is expected that institutional arrangements have a much greater impact on sustainability than physical items would have.

On the institutional side cost should be made for a framework of laws and by-laws which guide the use of a specific wetland. Then there is the task of monitoring and policing these specific wetland laws and arrangements, which should be taken into account.

For a better and sustainable use it may pay to give special rights to stakeholders and it seems logic that these stakeholders will be brought together in some sort of association (Wetland Users Association).

Finally one may expect that in certain wetlands in urban areas compensations have to be paid to users whose presence will no longer be wished because it leads to degradation or because it does not conform with the objectives of a specific wetland. Sometimes these users have historic right and have to be compensated.

7.5 eBA of lacustrine and permanently wet wetlands

Characteristics

The pressure on rural wetlands is much less than on urban wetlands and it seems likely that little degradation would take place when no intervention takes place. This means that the economic returns from the various human values these wetlands remains more or less the same or reduce slightly in the worst case scenario.

The changes in human use values over the project evaluation period have to be taken into account and should be compared to the gains or stabilisation of economic use value when some intervention takes place.

How much the modifications in non-use values would be when some intervention takes place is difficult to assess. Most rural wetlands do not seem to degrade very rapidly and this would mean that it is likely that non-use functions of these wetlands are hardly affected.

The non-use functions of urban wetlands must be safeguarded, as results of the interventions that take place, at least that should be the objective under the sustainability criterion.

Valuation techniques

The valuation techniques with respect to rural wetland functions are the same as those use to value urban wetland functions.

Cost of interventions

It seems probable that the focus of the interventions in rural wetlands would be on institutional arrangements and much less emphasis will be placed on to physical interventions.

This means that the majority of costs should be made for a framework of laws and by-laws that guide the use of a specific wetland. Then there is the task of monitoring and policing these specific wetland laws and arrangements, which should be taken into account.

For a better and sustainable use it may pay to give special rights to stakeholders and it seems logic that these stakeholders will be brought together in some sort of association (Wetland Users Association).

7.6 CSA of wetland development scenarios

In the final version of this report the wetland development scenarios will be costed and the incremental benefits estimated of each scenario. Subsequently, the profitability of each of the scenarios will be assessed on the basis of economic criteria like internal rate of return (IRR), and the net present value (NPV).

8 LITERATURE REFERENCES AND BIBLIOGRAPHY

To be added in the next version.

ANNEX I DISTRIBUTION OF WETLAND CLASSES PER PILOT AREA

Pilot area	Wellanddass	Tolal area (hal per class	Number of wetlands
Berl<ely BaylMcDonald Bay	RLF	26	1
	RLP	7209	17
	RSF	10238	15
	RSG	204	5
	RSA	2040	8
Napoleon Gulf	U	516	3
	RLP	1025	9
	RLC	37	1
	RSF	11	1
	RSG	73	1
	RSA	1120	6
Murchison Bay	U	3069	7
	RLF	533	8
	RLP	3161	11
	RLC	5552	15
	RSF	90	1
Sango Bay	RLF	73	1
	RLP	5136	5
	RLC	13725	12
	RSF	4029	11
	RSG	62847	11
	RSA	52	2
Ssese Islands	RLF	87	1
	RLP	26	1
	RLC	64	1
	RSF	393	2
	RSG	3945	7
All pilot areas	U	3585	3%
	RLF	719	1%
	RLP	16556	13%
	RLC	19378	15%
	RSF	14761	12%
	RSG	67070	54%
	RSA	3212	3%
	V		0%

ANNEX II NUMBER OF STAKEHOLDERS PER WETLAND CLASS

Pilot area	Wetland class	Stake-holders per class
Berkely Bay/McDonald Bay	RLF	384
	RLP	5270
	RSF	18208
	RSG	402
	RSA	7622
Napoleon Gulf	U	6673
	RLP	3022
	RLC	387
	RSF	127
	RSG	447
	RSA	7539
Murchison Bay	U	78234
	RLF	1947
	RLP	3711
	RLC	4832
	RSF	404
Sango Bay	RLP	4117
	RLC	12964
	RSF	2235
	RSG	56518
	RSA	241
Ssese Islands	RLF	10
	RLP	13
	RLC	492
	RSF	192
	RSG	1845

ANNEX III OVERVIEW OF LAND USE PER WETLAND CLASS IN EACH OF THE PILOT AREAS

Pilot area	Wetland class	Total area (hal per dass	Land use in each class (hal							
			Agricullure	Grass	Papyrus	Forest	Mixed veaetation	Mining	Open water	Habitations, roads, etc.
Berkely BayJMcDonald Bay	RLF	26				26				
	RLP	7209	1842	3174	1332	298	563			
	RSF	10238	1256	4977		1403	2602			
	RSG	204	20	143			41			
	RSA	2040	612	510		204	714			
Napoleon Gulf	U	516	77		128		172			138
	RLP	1025	262	451	189	42	80			
	RLC	37	1		18		17			
	RSF	11	1	5		1	3			
	RSG	73	7	51			15			
	RSA	1120	336	280		112	392			
Murchison Bay	U	3069	697		1528		195	55	28	566
	RLF	533	59	31		384	56	3		
	RLP	3161	9		3120		16	10		5
	RLC	5552	145		2782		2624			
	RSF	90	18			72				
Sango Bay	RLF	73				73				
	RLP	5136	1027		3338	257	436			
	RLC	13725	686	686	1373	686	10294			
	RSF	4029	482		1322	1931	295			
	RSG	62847	628	55934		6285				
	RSA	52	47	5						
Ssese Islands	RLF	87			26	22	35			4
	RLP	26			13	3	10			
	RLC	64			10	6	48			
	RSF	393	20			354				20
	RSG	3945	197	3156		197	197			197

ANNEX IV SPAWNING AREAS FOR FISH REPRODUCTION

Pilot area	Wetland class	Potential spawning area (hal
Berkely Bay /McDonald Bay	RLF	26
	RLP	7209
	RSF	10149
	RSG	117
	RSA	1304
	Sub-total	18805
Napoleon Gulf	U	516
	RLP	1603
	RLC	37
	RSF	11
	RSG	73
	RSA	1193
	Sub-lota l	3433
Murchison Bay	U	1799
	RLF	533
	RLP	3161
	RLC	5552
	Sub-tota l	11044
Sango Bay	RLF	73
	RLP	5136
	RLC	13725
	RSF	4016
	RSG	62847
	RSA	52
	Sub-total	85849
Ssese Islands	RLF	87
	RLP	26
	RLC	64
	RSF	393
	RSG	3945
	Sub-lotal	4515

ANNEX V CROPPING SYSTEM BUDGETS

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Cocoyam-Sugarcane in Urban wetlands
BUDGETIa

	Unit	auantities	Urban wetlands Financial budget	Urban wetlands Economic budget
			(In USh '000/ha)	
Revenue				
Cocoyam (urban)	kg	2500	750	638
Sugarcane (urban)	kg	4500	1350	1148
Sub-total Revenue			2100	1785
Labour costs				
Labour	persday	115	288	216
Income (After Labour Costs)			1813	1569
Returns to labour (USh/persday)			18261	15522

SCF=O.85; SWR=0.75
Ia land use: cocoyam 50%, sugarcane 50%

References:
L. Emerton ea., 1999, The present economic value of Nakivubo urban wetland, Uganda (IUCN)
HASKONING ea., 2000 and 2001, Field observations
Agricultural Policy Committee, 1999, Report on economics of crops and livestock production, processing and marketing 1998/99

Assumptions:
The present crop budget applies to all urban wetlands in the pilot areas

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Staple foodcrops-Vegetables in Urban wetlands
BUDGETIa

	Unit	auantities	Urban wetlands Financial budget	Urban wetlands Economic budget
			(In USh '000/ha)	
Revenue				
Staple foodcrops (urban)	kg	2500	625	531
Mixed vegetables (urban)	kg	2400	1440	1224
Banana (urban)	kg	80	22	19
Sub·total Revenue			2087	1774
Input costs				
Fertiliser	ha		49	42
Income (Before Labour Costs)			2038	1733
Labour costs				
Labour	persday	170	425	319
Income (After Labour Costs)			1613	1414
Returns to labour (USh/persday)			11991	10192

SCF=O.85; SWR=O.75
Ia Land use: staples 50%, vegetables 40% and banana 10%

References:
L. Emerton ea., 1999, The present economic value of Nakivubo urban weiland, Uganda (IUCN)
HASKONING ea., 2000 and 2001, Field observations
Agricultural Policy Committee, 1999, Report on economics of crops and livestock production, processing and marketing 1998/99

Assumptions:
The present crop budget applies to all urban wetlands in the Pilot Areas

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Cocoyam-Sugarcane in Rural wetlands
BUDGETIa

	Unit	Quantities	Rural wetlands Financial budget	Economic budget
			(In USh '000/ha)	
Revenue				
Cocoyam (rural)	kg	2 500	500	425
Sugarcane (rural)	kg	4 500	900	765
Sub-total Revenue			1400	1190
Labour costs				
Labour	persday	115	173	129
Income (After Labour Costs)			1228	1061
Returns to labour (UShlpersday)			12174	10348

SCF=O.85; SWR=0.75
Ia land use: cocoyam 50%, sugarcane 50%

References:
L. Emerton ea., 1999, The present economic value of Nakivubo urban wetland, Uganda (IUCN)
HASKONING ea., 2000 and 2001, Field observations
Agricultural Policy Committee, 1999, Report on economics of crops and livestock prOduction, processing and marketing 1998/99

Assumptions:
The present crop budget applies 10 all rural wetlands in the pilot areas

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Maize-Staple foodcrops in Berkely BaylMcDonald Bays
BUDGETIa

	Unit	Quantities	Berkery Bay /McDonald Bay Financial budget	Economic budget
			(In USh '000/ha)	
Revenue				
Maize (rural)	kg	1250	175	149
Staple foodcrops (rural)	kg	1750	306	260
Leguminous crops (rural)	kg	120	80	68
Sub-total Revenue			562	477
Labour costs				
Labour	persday	120	180	135
Income (After Labour Costs)			382	342
Returns to labour (UShlpersday)			4680	3978

SCF=0.85; SWR=0.75
Ia Land use: maize 50%, staples 35%, leguminous crops 15%

References:
HASKONING ea., 2000 and 2001, Field observations
Agricultural Policy Committee, 1999, Report on economics of crops and livestock production, processing and marketing 1998/99

Assumptions:
The present crop budget applies to rural wetlands in Berkely Bay/McDonald Bay

Republic of Uganda (Loan 2909 UG)
Cost Benefrt Analysis of Wetlands Resources
Rice In Berkely BaylMcDonald Bay
BUDGET \a

	Unit	Quantities	Berkely Bay /McDonald Bay Financial budget	Economic budget
			(In USh 'Ooolha)	
Revenue				
Paddy	kg	2290	1042	886
Labour costs				
Labour	persday	150	225	169
Income (Alter Labour Costs)			817	717
Returns to labour (UShlpersday)			6946	5904

SCF=O.85; SWR=0.75
\a Land use: swamp rice 100%

References:
HASKONING ea., 2000 and 2001, Field observations
Agricullural Policy Committee, 1999, Report on economics of crops and livestock production, processing and marketing *1998199*

Assumptions:
The present crop budget applies to rural wetlands in Berkely Bay/McDonald Bay

Republic of Uganda (Loan 2909 UG)
Cos1 Benefit Analysis of Wetlands Resources
Vegetables-Staple foodcrops in Sango Bay
BUDGET \a

	Unit	Quantities	Sango Bay Financial budget	Economic budget
			(In USh 'Ooolha)	
Revenue				
Staple foodcrops (rural)	kg	1750	306	260
Mixed vegetables (rural)	kg	3300	1320	1122
Banana (rural)	kg	80	16	14
Sub-total Revenue			1642	1396
Input costs				
Fungicide	ha		74	63
Income (Before Labour Costs)			1568	1333
Labour costs				
Labour	persday	125	188	141
Income (Alter Labour Costs)			1381	1192
Returns to labour (UShlpersday)			12544	10662

SCF=0.85; SWR=O.75
\a Land use: vegetables 55%, staples 35%; banana 10%

References:
HASKONING ea., 2000 and 2001, Field observations
Agricul1ural Policy Committee, 1999, Report on economics of crops and livestock production, processing and marketing *1998199*

Assumptions:
The present crop budget applies to all rural wetlands in Sango Bay

ANNEX VI BUDGETS FOR THE HARVEST OF NATURAL PRODUCTS

Republic of Uganda (Loan 2909 UG)
Cost Benefrt Analysis of Wetlands Resources
Papyrus harvesting in Urban wetlands
BUDGETIa

	Unit	Quantities	Urban wetlands Financial budget	Urban wetlands Economic budget
			(In USh 'OOOlha)	
Yields	kg	2000	150.0	127.5
Operating				
Labour (urban)	persday	85	212.5	159.4
Income (After Labour Costs)			-62.5	-31.9
Returns to Labour (UShipersday)			1 765	1 500

\a Only 10% of the total area is harvested

References:
L. Emerton ea., 1999, The present economic value of Nakivubo urban wetland, Uganda (IUCN)
NWP, unpublished, Economic evaluation of Masaka District wetlands
HASKONING ea., 2000 and 2001, Field observations

Assumptions:
The value of papyrus (opportunity cost) is defined by the value of the raw product sold for further processing

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Papyrus harvesting in Rural wetlands
BUDGETIa

	Unit	Quantities	Rural wetlands Financial budget	Rural wetlands Economic budget
			(In USh 'OOOlha)	
Yields	kg	400	22.0	18.7
Operating				
Labour (rural)	persday	17	25.5	19.1
Income (After Labour Costs)			-3.5	-0.4
Returns to Labour (USh/persday)			1294	1100

\a Only 2% of the total area is harvested

References:
L. Emerton ea., 1999, The present economic value of Nakivubo urban wetland, Uganda (IUCN)
NWP, unpublished, Economic evaluation of Masaka District wetlands
HASKONING ea., 2000 and 2001, Field observations

Assump1ions:
The value of papyrus (opportunity cost) is defined by the value of the raw product sold for further processing

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Phoenix poles in Rural wetlands
BUDGETIa

	Unit	Quantities	Rural wetlands Financial budget	Rural wetlands Economic budget
			(In USh '0oolhal	
Yields	unit	1.5	1.05	0.89
Operating				
Labour (rural)	persday		0.45	0.34
Income (After Labour Costs)			0.60	0.56
Returns to Labour (UShlpersday)			3500	2975

\a Only 10% of the area is harvested

References:
HASKONING ea., 2000 and 2001 , Field observations
Information from Jinja District Office, 2001

Assumptions;
Poles are delivered on the road site and sold there to passing trucks that take them to Kampala or Jinja

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Foresl products in Rural wetlands
BUDGETIa

	Unit	Quantities	Rural wetlands Financial budget	Rural wetlands Economic budget
			(In UShihal	
Yields	tonne	0.7	11	9
Operating				
Labour (rural)	tonne		3	2
Income (After Labour Costs)			B	7

\a Combination of Acacia, Alabizia, Lantana and Vernonia; only 10% of the area is harvested

References:
HASKONING ea., 2000 and 2001 , Field observations
Information from Jinja District Office, 2001

Assumptions:
Timber/firewood is delivered on the road site and sold there to passing trucks that take it to Kampala or Jinja

ANNEX VII BUDGETS FOR BRICK MAKING

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Brick making (per kiln per production cycle)
BUDGET

	Unit	Quantities	Urban wetlands Financial budget	Urban wetlands Economic budget
			(In USh '000)	(In USh '000)
Revenue	brick	13000	910	774
Input costs				
Firewood	tonne	12.5	266	244
Income (Before Labour Costs)			623	529
Labour costs				
Mining clay	persday	22.5	56	42
Mou lding bricks	persday	75.0	166	141
Stacking for firing	persday	7.5	19	14
Sealing kiln	persday	3.0	6	6
Firing kiln	persday	15.0	3B	26
Sub-total Labour costs		123	308	231
Income (After Labour Costs)			315	299
Returns to labour (UShlpersday)			5061	4302

SCF=0.65; SWR=0.75
\a Kilns contain 15,000 bricks per cycle (13,000 are marketable); there are 5 cycles per year using 1 ha of wetland (=75,000 bricks/ha/year)

References:

L. Emerton ea., 1999, The present economic value of Nakivubo urban wetland, Uganda (IUCN)
HASKONING ea., 2000 and 2001, Field observations
NWP, unpublished, Economic evaluation of Masaka District wetlands
IUCN, 1996, Initial environmental assessement of brick·making in Mukono District

Assumptions
Brick-making cycle takes 1.5 month, per year there are 6 production months (during the dryer period of the year)

Brick-making cycle uses truckload of firewood, approximately 10-15 tonnes of wood
Brick-prices vary between USh 70 (near urban centres) and USh 35 (rural areas)

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Brick making (per kiln per production cyde)

BUDGET	Unit	Quantities	Rural wetlands Financial budget	Rural wetlands Economic budget
			(In USh '000)	
Revenue	brick	2600	91	77
Input costs				
Firewood	tonne	2.5	35	30
Income (Before Labour Costs)			56	48
Labour costs				
Mining clay	persday	4.5	7	5
Moulding bricks	persday	15.0	23	17
Stacking for firing	persday	1.5	2	2
Sealing kiln	persday	0.6	1	1
Firing kiln	persday	3.0	5	3
Sub-total Labour costs		25	37	28
Income (After Labour Costs)			19	20
Returns to labour (USh/persday)			2276	1935

SCF=O.85; SWR=0.75

\a Kilns contain 3,000 bricks per cycle (2,600 marketable); there 5 cycles per year using 1 ha of wetland (=15,000 bricks/ha/year)

References:

L. Emerton ea., 1999, The present economic value of Nakivubo urban wetland, Uganda (IUCN)
HASKONING ea., 2000 and 2001 , Field observations
NWP, unpublished, Economic evaluation of Masaka District wetlands
IUCN, 1996, Initial environmental assessement of brick-making in Mukono District

Assumptions

Brick-making cycle lakes 1.5 month, per year there are 8 production months (during the dryer period of the year)

Brick-making cycle uses 1 tractor trailer load of firewood, approximately 2-3 tonnes of wood
Brick-prices vary between USh 70 (near urban centres) and USh 35 (rural areas)

ANNEX VIII CASH FLOW FOR A WASTE STABILISATION SYSTEM OF PONDS (AN-AEROBIC, FACULTATIVE AND MATURATION POND)

RepubrlC 01 Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Waste water treatment Facility
FINANCIAL BUDGET
(In USh '000) /a

	Years									
	1102	3107	8	91013	14	151019	20	211025	26	271030
Cosls										
Capital cosls	1656									
Operating Cosls										
Recurrent costs		141	141	141	141	141	141	141	141	141
Sludge removal			195		195		195		195	
Interest on capital		129	129	129	129	129	129	129	129	129
Sub-total Operaling Cosls		270	465	270	465	270	465	270	465	270
Sub-total Costs	1656	270	465	270	465	270	465	270	465	270

NPV = 4666.43
Annual cost of removal = USh 388 000 (no discounting)
Ia Costs per lonne BOD removed

Source:
Tom Okia Okurut, 2000, A pilot study on municipal wastewater treatment using a constructed wetland in Uganda (PhD dessertation)

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Waste water treatment Facility
ECONOMIC BUDGET
(In USh '000) /a

	Years									
	1102	3 t07	8	91013	14	15 to 19	20	211025	26	27 to 30
Cosls										
Capital costs	1349									
Operaling Costs										
Recurrent costs		120	120	120	120	120	120	120	120	120
Sludge removal			166		166		166		166	
Sub-total Operating Costs		120	286	120	286	120	286	120	286	120
Sub-total Cosls	1349	120	286	120	286	120	286	120	286	120

NPV = 3169.17
Annual cost of removal = USh 224 000 (no discounting)
Ia Costs per kg BOD removed

Source:
Tom Okia Okurut, 2000, A pilot study on municipal wastewater treatment using a cons1rucled wetland in Uganda (PhD dessertation)

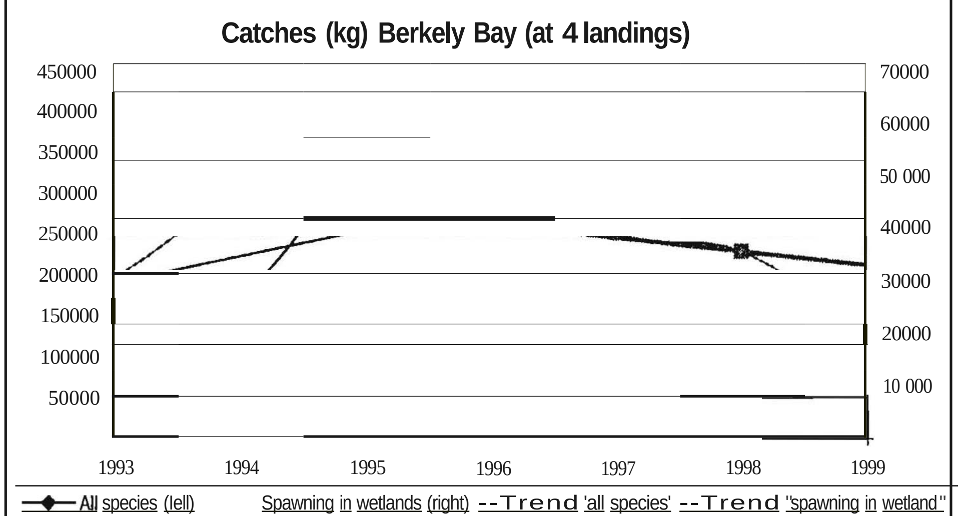
ANNEX IX TECHNICAL DATA SHEETS AND BUDGETS FISHERY

This annex contains details of fish catches:

1. Technical data sheet of catches at four landing sites in Berkeley Bay
2. Technical data sheet of catches at three landing sites in Napoleon Gulf
3. Budget for fish catching in Napoleon Gulf and Berkeley Bay

Year	landing	Oreochromis niloticus (Tilapia)		lates niloticus (Nile perch)		*Protop/elUs (Lung fish)*		*Clarias(Catfish or Mudfish)*		Synodontis		*Schilbe*		*Labeo*		*Alestes*		Others	
		Kg	'000 USh	Kg	'000 USh	Kg	0000 USh	Kg	0000 USh	Kg	'000 USh	Kg	'000 USh	Kg	'000 USh	Kg	0000 USh	Ka	0000 USh
1993	Fresh fish	25900	10400	29520	10300	240	100	50	50	4200	2500	1 200	720	1400	840	400	160		
	Cured fish 1)	28395	10275	34 071	5178													20850	2369
1994	Fresh fish	49000	19400	62200	19900	240	120	20	160	840	570			440	260	1200	550		
	Cured fish 1)	40440	14283	17523	3726													4986	536
1995	Fresh fish	75560	30930	101100	43 600	90	50	1690	940	1430	870	2100	1250	760	450	1260	630	600	120
	Cured fish 1)	31094	11270	68571	16425													46715	*5092*
1996	Fresh fish	75000	34600	48400	33 200			570	460	340	270	90	70	430	380	30	20		
	Cured fish 1)	32578	10866	97101	24466													72962	7733
1997	Fresh fish	40300	18240	29400	17 500	120	80	1840	1540	650	520	40	80	630	500	200	120		
	Cured fish 1)	32313	*10463*	125631	*32506*													*99208*	*10373*
1998	Fresh fish	29800	16600	67600	40600	300	130	1500	970	270	160	2350	1410	20	10	600	280		
	Cured fish 1)	*32047*	*10060*	r54161	*40546*													125455	13013
1999	Fresh fish	13220	7400	29900	20300	1050	600	200	140			100	70			800	40		
	Cured fish 1)	22650	6612	159870	42712													58200	9250

1) In fresh fresh fish eqUivalents



	All species (left)	Spawning in wetlands (riaht) ,	Unit
Annual change	31896	·2607	kg/year
%	11%	·6%	
Wetlands reoresent		33051	ka in 1999

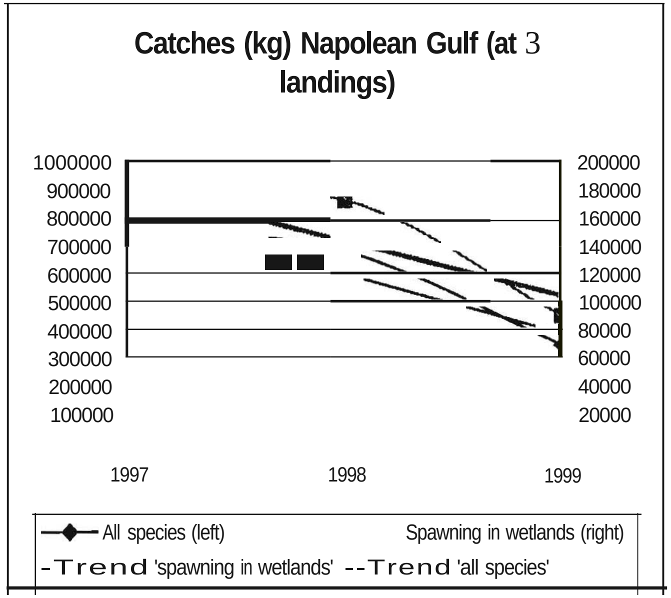
• Species in italic and 50% Oreochromis nilotocus (Sio R.)

	Averac e-price		Catch	fresh)
1999	306	UShlkg	284940	kg
1998	299	UShlkg	413804	kg
1997	278	UShlkg	330212	kg
Ava.	294	USh/kg	342985	kg

Prices refer to fresh tish equivalents, and because 01 the importance of cured fish the average is lowered as 1 kg of cured fish equals 3 kg of fresh fish

Spawning area (wetlands)	6590	ha
Catch per spawning area	5.02	kglha
Growth rate	-6%	

Landinq site	Year	Oreochromis spp		Lates		*Pr%oteTUs spp*		*C/ariassoo*		Ba rus		Rastrineobola	
		Kg	000 USh	Kg	000 USh	Kg	000 USh	Kg	000 USh	Kg	000 USh	Kg	000 USh
Masese	1999	78759	66243	6666	4885	678	501	5	5				
	1998	211270	170782	23417	16906	737	510	73	59				
	1997	183044	157277	51241	35916	1790	980	101	121	166	199		
Wanyange	1999	29087	24920	666	394	829	288	12	12			225	68
	1998	42063	31822	6682	4017	2504	1046	70	39			225	68
	1997	61485	52774	727	608	831	399	482	295				
Wairaka	1999	67817	47946	10695	7211	1150	476	44	43				
	1998	78776	58286	17 073	10677	3341	1471	80	79			1010	331
	1997	83777	133112	2062	1826	659	287	110	95				
Summary	1997	328306	343164	54030	38350	3280	1665	693	511	166	199		
	1998	332109	260890	47172	31600	6582	3027	223	177		-	1235	399
	1999	175663	139109	18027	12489	2657	1264	61	59			225	68



	All species (left)	Spawning in wetlands (riqht) ,	Unit
Annual change	-210371	-38 788	kglyear
%	-35%	-27%	
Wetlands represent ..		105057	kg in 1999

, Species in italic and 50% Oreochromis nilotocus (as a large part spawns near beaches)
From originbal trend analysis

	Avera e price		Catch	
1999	778	UShlkg	196633	kg
1998	764	USh/kg	387321	kg
1997	993	UShlkg	386475	kg
Overall avg.	858	UShlkg	323476	kg

Spawning area (wetlands)	2206	ha
Catch per spawning area	47.62	kg/ha
Growth rate (corrected)	-6%	

Republic of Uganda (Loan 2909 UG)
Cost Benefit Analysis of Wetlands Resources
Fish catching models
BUDGET

	Unit	Quantities	Napoleon Gulf Financial budget (In USh '000)	Napoleon Gulf Economic budget (In USh '000)	Berkely Bay Financial budget (In USh '000)	Berkely Bay Economic budget (In USh '000)
Catch	kg	12000	10200	8670	3540	3009
Operating costs						
Inputs						
Depreciation boats	year	2	35	30	35	30
Interest boats	%	20	4		4	
Depreciation outboards motor (5HP)	year	5	400	340	400	340
Interest on outboards motor (5HP)	%	20	40		40	
Fuel outboards motor (5HP)	Vweek	10	800	680	800	680
Maintenance cost outboard motor (5HP)	%price	25	500	425	500	425
Gill nets	unit	4	140	119	140	119
Cast nets	unit	1			20	17
Seine nets	unit	1			75	64
SUb-total Input costs			1919	1594	2014	1675
Income (Before Labour Costs)			8282	7076	1527	1335
Labour costs						
Labour	persday	810	2025	1519	1215	911
Income (After Labour Costs)			6257	5558	312	423
Returns to labour (UShlpersday)			10224	8736	1885	1648
Returns per kg catch (UShlkg)			521	463	26	35

SCF=0.85; SWR=0.75

References:
Statistics of landed catches from Fisheries Department for Busia District and Napoleon Bay
HASKONING ea., 2000 and 2001, Field observations

Assumptions
Each fish catching unit consists of 3 persons, 1 boat (24 lt) with outboard motor (5HP)
The number of nets is per fishing unit in Napoleon Bay: 4 gill nets (4.5; 2x6 and 7 inch mesh size)
In Berkely Bay still prohibited cast nets and seine nets are used, a fishing unit has one of each
Per fishing unit about 1 tonne of fish is caught every month
Per fortnight fishermen work approximately for 10 days, the other days are used for rest, lost due to bad weather, etc.

ANNEX X SUMMARY OF HUMAN USE WETLAND VALUES

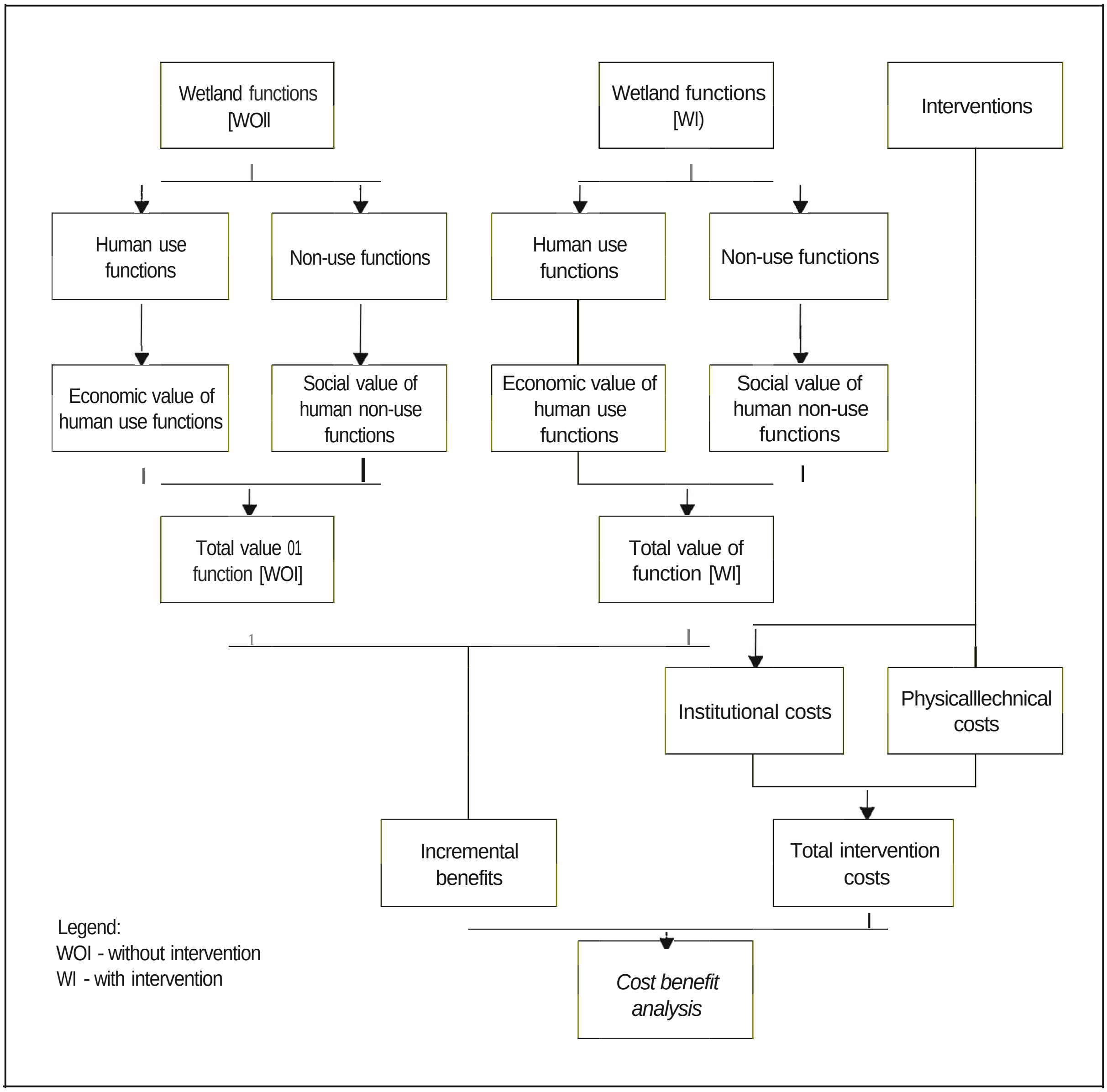
Pilot Area	Activity	Values lin Million UShl	
		Financial (before labour)	Economic (after labour)
Berkely BaylMcDonald Bay	Farming	2764.3	1799.1
	Papyrus halVesting	29.3	-0.6
	Phoenix poles	1.1	0.6
	Timber and firewood	0.0	0.0
	Brick-making		
	Domestic water	1 629.4	1163.8
	Wastewater treatment		
	Fish reproduction	48.0	13.3
	Sub-total	4472.1	2976.2
Napoleon Gulf	Farming	1 091.5	805.5
	Papyrus halVesting	23.7	-4.2
	Phoenix poles	0.5	0.3
	Timber and firewood	0.0	0.0
	Brick-making		
	Domestic water	929.7	664.1
	Wastewater treatment	16.9	9.7
	Fish reoroduction	112.8	75.7
	Sub-total	2175.2	1551.2
Murchison Bay	Farming	1800.3	1320.0
	Papyrus halVesting	359.0	-51.2
	Phoenix poles	2.8	1.5
	Timber and firewood	0.0	0.0
	Brick-making	174.2	83.1
	Domestic water	4554.4	3253.2
	Wastewater treatment	495.7	286.2
	Fish reproduction	363.0	243.6
	Sub-total	7749.4	5136.3
Sango Bay	Farming	4332.1	3214.6
	Papyrus halVesting	132.7	-2.6
	Phoenix poles	9.6	5.1
	Timber and firewood	0.1	0.1
	Brick-making	-	
	Domestic water	3887.4	2776.7
	Wastewater treatment		
	Fish reproduction	219.1	60.7
	Sub-total	8581.0	6054.6
Ssese Islands	Farming	343.1	251.4
	Papyrus halVesting	1.1	-0.0
	Phoenix poles	0.3	0.2
	Timber and firewood	0.0	0.0
	Brick-making		
	Domestic water	130.4	93.1
	Wastewater treatment		
	Fish reoroduction	11.5	3.2
	Sub-total	486.4	347.9

ANNEX XI WETLAND SCENARIOS

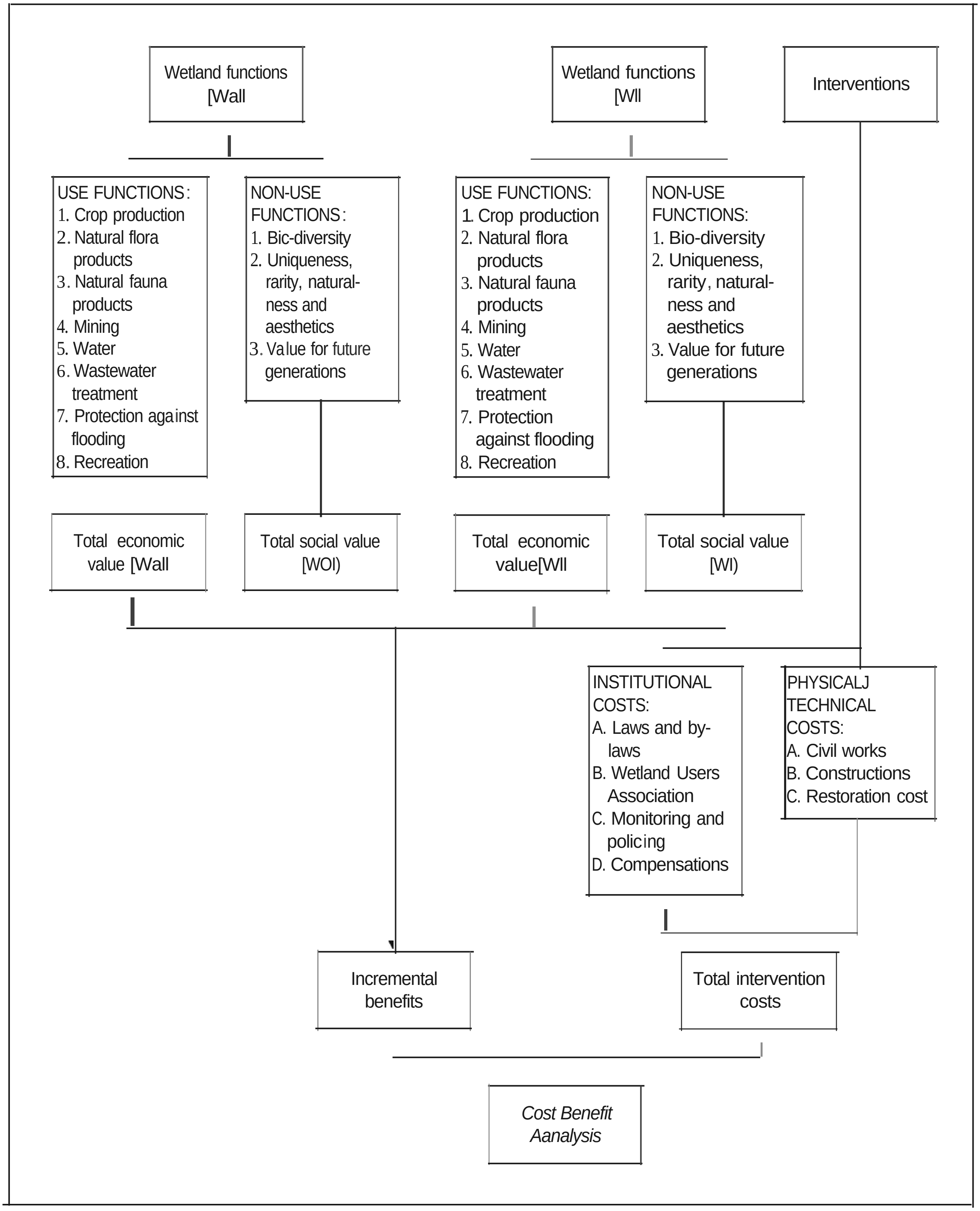
Main characteristic	*Hydrological condition*	*Dominant vegetation*	*Code*	*Scenarios*
Urban			U	1) No intervention; 2) Preservation of the current situation; 3) Mix: - primarily waste water treatment, - agriculture/ extraction of other products in dedicated areas; 4) Optimisation for waste water treatment.
Rural	Lacustrine or permanently wet	Forest	RLF	1) No intervention; 2) Preservation of the current situation; 3) Mix: • primarily protection of the natural flora & fauna, - agriculture/ extraction of other products in dedicated areas.
		Papyrus	RLP	1) No intervention; 2) Preservation of the current situation; 3) Mix: - primarily protection of the natural flora & fauna, - agriculture/ extraction of other products in dedicated areas.
		Cyperus dives/ rotunda, Vossia, Miscanthus, Phragmites	RLC	1) No intervention; 2) Preservation of the current situation; 3) Mix: - primarily protection of the natural flora & fauna, - agriculture/ extraction of other products in dedicated areas.
	Riverine or seasonally wet	Forest (including palms & thickets)	RSF	1) No intervention; 2) Preservation of the current situation; 3) Mix: - primarily protection of the natural flora & fauna, - agriculture/ extraction of other products in dedicated areas.
		Grass	RSG	1) No intervention; 2) Preservation of the current situation; 3) Mix: - primarily protection of the natural flora & fauna, - agriculture/ extraction of other products in dedicated areas.
		Agriculture	RSA	1) No intervention; 2) Preservation of the current situation; 3) Mix: - restoration of natural flora & fauna in some areas, - agriculture/ extraction of other products in dedicated areas.
Vital or Unique			V	2) Preservation of the current situation; 4) Optimisation for unique or vital function/ value.

ANNEX XII MODELS FOR THE CSA OF WETLANDS

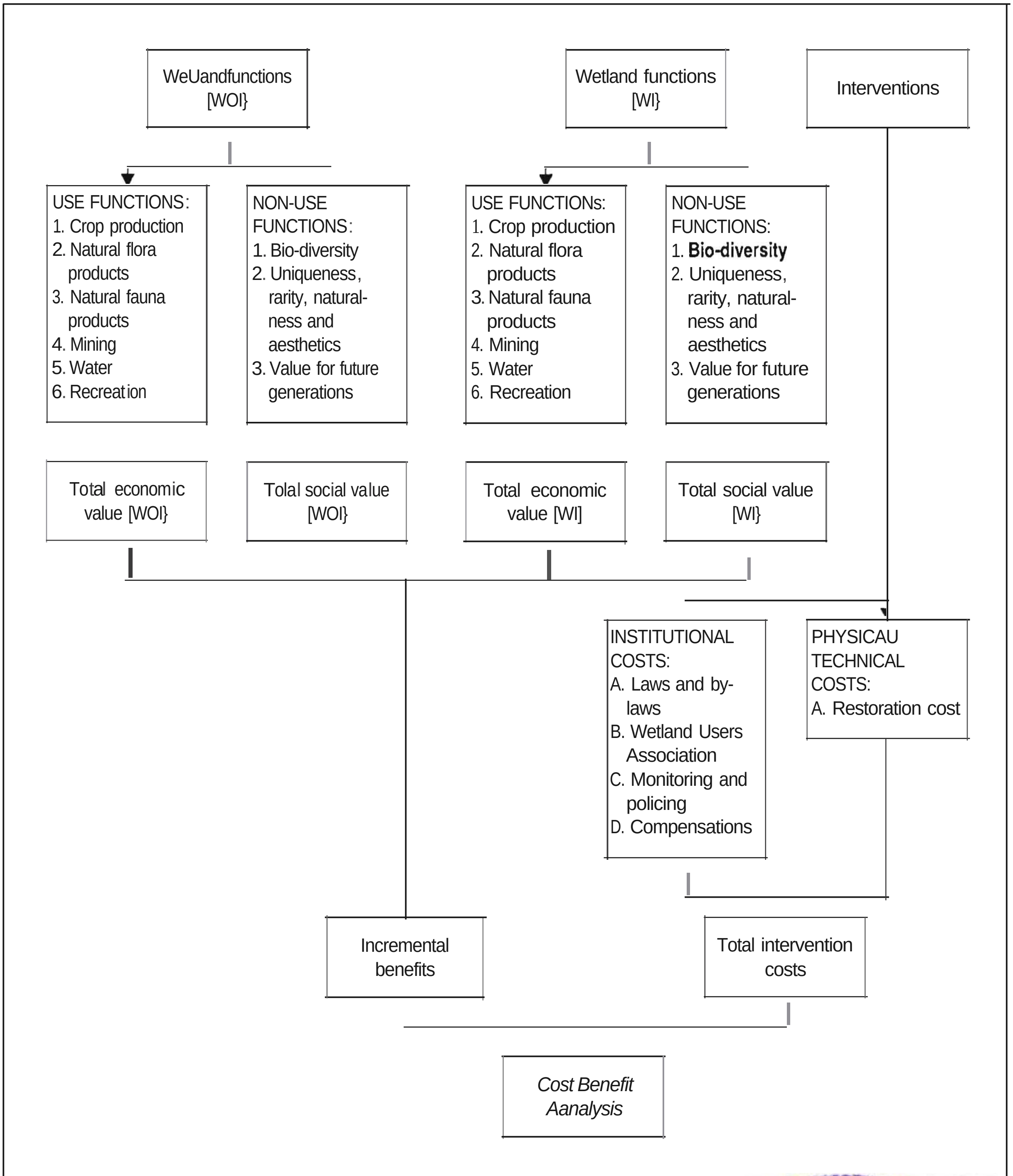
General Model for the cost benefit analysis of individual wetlands:



Model for the analysis of urban wetlands:



Model for the analysis of rural wetlands:



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